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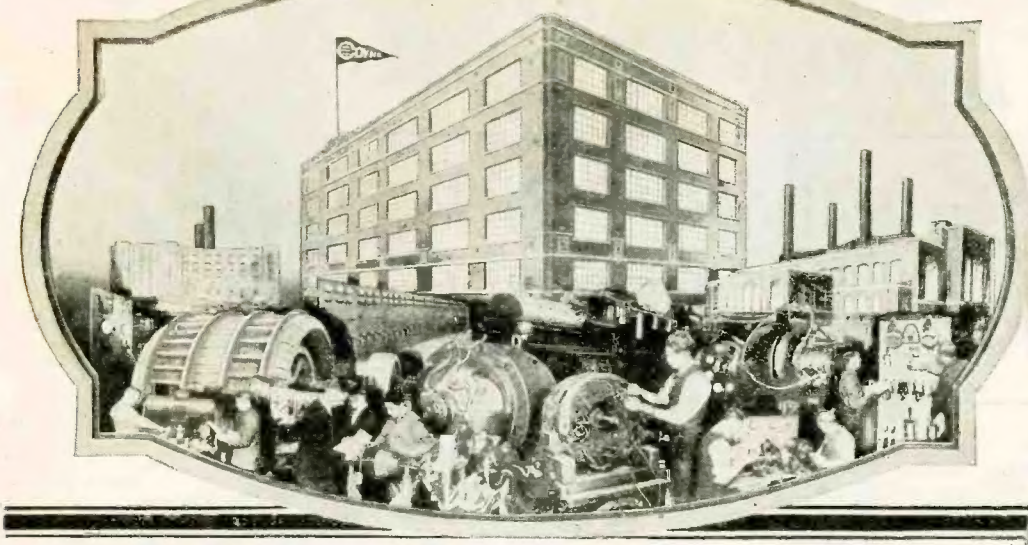

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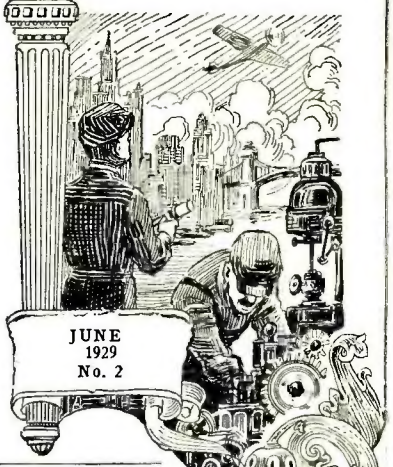
Science and Invention



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IN OUR NEXT ISSUE

A New Trans-Atlantic Flight

Mr. Post, the aeronautical editor, has interviewed the plane designer and presents some interesting matter.

An Automatic Garage

A new skyscraper garage by means of which 1,000 cars can be conveniently parked in the most congested cities will be described and illustrated.

Artistic Hardwood Floors

An article dealing with the laying of these floors and the fine points of design.

Setting Type by Wire

How type is set by wire with a new device known as the "Teletypesetter." One operator can control hundreds of typesetting machines positioned throughout the country.

Scientific Fiction

"The Invisible Incendiary" is a thrilling scientific mystery story which will appeal to our readers.

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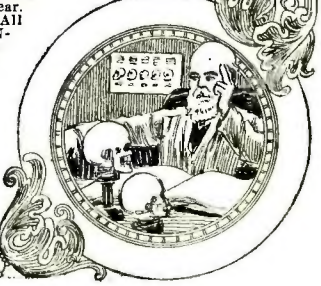
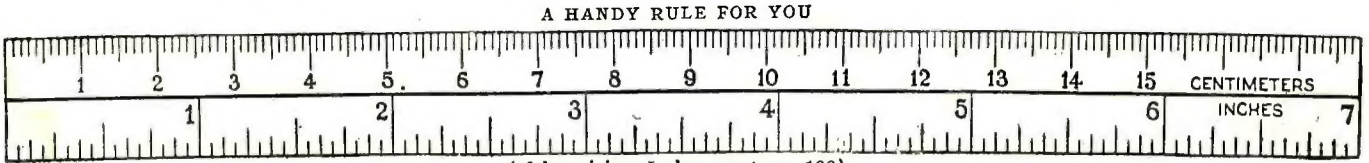


A HANDY RULE FOR YOU



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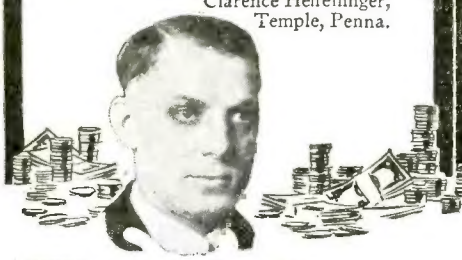

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"In addition to my regular work in what I believe to be the largest and best equipped Radio Shop in the Southwest, I am now operating KGFI. I am proud of the fact that I installed and put KGFI on the air without help of anyone except the N. R. I. I am averaging $450 per month."

Frank M. Jones, 922 Guadalupe St., San Angelo, Tex.

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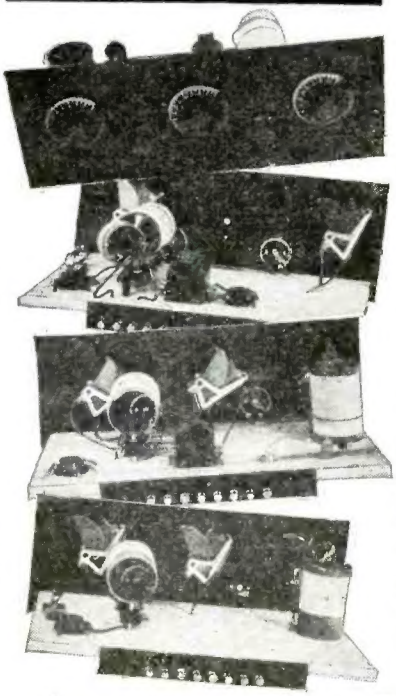

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Miss Amelia Earhart, Trans-Atlantic Flier, Takes to Gliding

Miss Earhart is here seen at the controls of a glider, in which engineless craft she experienced some of the greatest thrills in her career as an air-woman. This excellent picture of Miss Earhart seated on the glider just prior to "taking off," was photographed at Bloomfield Hills, Michigan, while on a visit to that winter resort. Gliders lend themselves equally well to winter and summer sport requirements.

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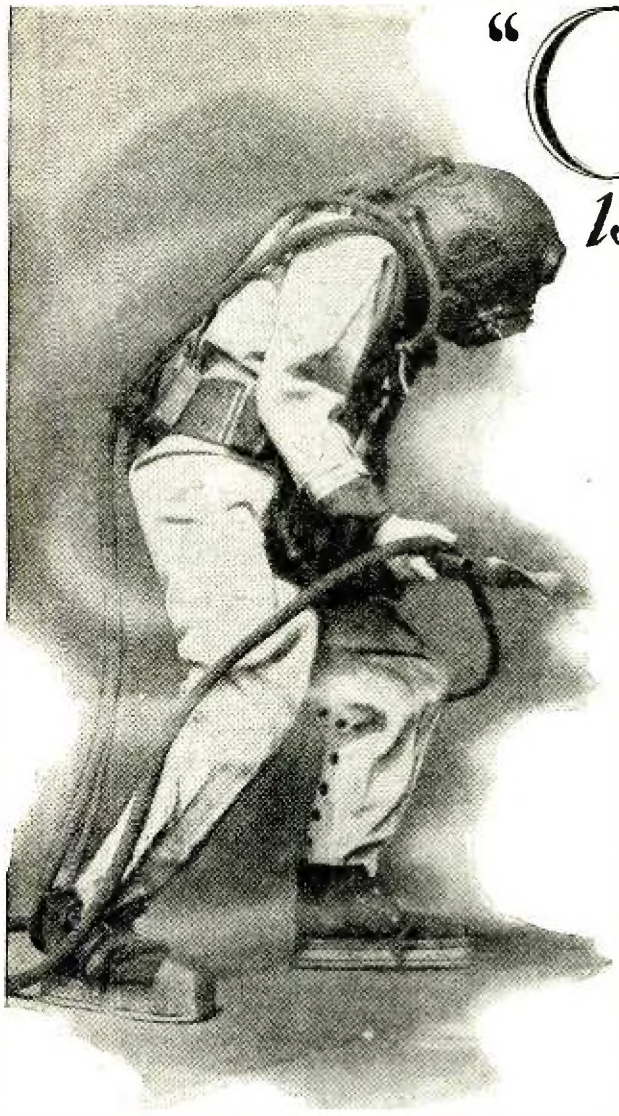

This illustration is a reproduction of a photograph of Commander Edward Ellsberg in a diving rig with an air drill rigged for underwater use
(Description dictated by Commander Ellsberg)

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Editorial

"Those Who Refuse to Go Beyond Fact Rarely Get as Far as Fact" - - HUXLEY

The Glider Craze

GLIDERS are about to become very popular in this country, if we can judge by the interest manifested by the surprising number of glider flying clubs, which have already been formed. Almost everyone knows that in the period since the war, the art of gliding and soaring with motorless planes has been developed to a very high degree in Germany.

Practically all of the early research work in flying was performed by means of gliders. The first successful one was made in the early part of the nineteenth century by an Englishman, Sir George Cayley. The most scientific investigations in the art of gliding were conducted by Otto Lilienthal and his brother, Gustave, in Germany, where they studied carefully the flight of storks. Otto Lilienthal made more than one thousand successful flights, and in fact he wrote a book describing these flights. Mr. Augustus Post, famous American aviation authority, tells us in his new book, "Aero Mechanics," that so interesting was Otto Lilienthal's description of his successful glider flights, that it inspired the Wright brothers to take up the study of flying. Not everyone perhaps realizes that the Wright brothers at first built gliders, and carried on a number of successful flights with them at Kitty Hawk, North Carolina.

If you were asked the question, whether you would rather learn to fly by means of a glider, or by means of a motor-driven plane, you would probably choose the craft driven by power; this answer being qualified, of course, by the fact that you would have to be given flying lessons by a competent and experienced pilot. There are a large number of aviation fields scattered over the country, and a great many people visit these flying fields more or less frequently. At most of these fields, flying lessons are given at a reasonable price, and in this way the "feel of the air" can be obtained more quickly than in any other way. On the other hand, for those who do not have access to a flying field, there are at least two channels opened up; the first being that you may learn to fly a glider yourself, by running down a hill with it, or by having it towed by an automobile or otherwise; secondly, you may be fortunate enough to have an experienced aviator in your locality who can help you in building and learning to fly a glider or home-built plane. In any event, and assuming that you have built either a glider or a home-made motor-driven airplane, it is always the best policy to have an experienced aviator look over the plane before you attempt to fly it. You may have to pay him for his advice, and check-up of the plane before it is flown at all, but it will be well worth it. If you have no flying experience at all, you should certainly endeavor to obtain a trained flier to take the plane aloft, once he has satisfied himself that the plane is thoroughly airworthy. After an experienced pilot has flown the plane and found it satisfactory, you will have more confidence in the machine than you could possibly have otherwise. Undoubtedly one of the best ways of learning to fly is to go up with a pilot in a two-place machine, preferably one fitted with dual control. In this way the skilled pilot can teach you step by step, how to control the plane in actual flight. On the other hand, some people have learned to fly all by themselves, and Augustus Post, the American aeronaut, told the writer that he himself learned to fly in this manner.

If you have never flown in an airplane, then you still have one of the greatest thrills of your life in store. One of the beauties of the gliding craze, which is now starting to sweep over the country, is the fact that plans for building successful gliders are available from a number of different sources. In this issue we publish plans for building successful gliders of various types, and with regard to the cost of building one, it may be said that the parts may be purchased for about $100.00. Completely finished gliders are available for about $500.00 and some of the better made models run up to $1,000.00 or more. If one follows the plans which we are making available, he may build a glider at a really slight cost, as a considerable part of the cost of a glider lies in the cutting and forming of the wing ribs and other wooden members. The cloth with which the glider wings are covered may be either linen airplane cloth, or else one of the new varieties of specially woven cotton airplane cloth.

At this point, it is well to consider the differentiation between gliding and soaring. Both gliding and soaring are accomplished with a motorless plane, with the difference that gliding is considered to be that phase of flying where the passenger and plane descend from a higher to a lower level. In soaring, the pilot of the motorless craft may swing around in figure-eight and other convolutions for hours, proceeding to take advantage of the various air currents as he feels them out. Great enthusiasm was aroused in this country in 1928 when Peter Hesselbach accomplished some very remarkable flights with his motorless glider at Corn Hill on Cape Cod, Massachusetts. Hesselbach was able to keep on soaring for a period of four hours and five minutes. Glider fiights have been made to a height as great as 2,700 feet, and so far as the duration or time in the air is concerned, periods as long as fourteen hours have been negotiated. A distance of over 300 miles has been covered in a single continuous soaring flight with a glider. Hesselbach flew a Darmstadt sailplane at Corn Hill on Cape Cod, where he established a new record for gliding in the United States.

Glider flying clubs are forming rapidly with the approach of summer weather.

H. Winfield Secor

Managing Editor.

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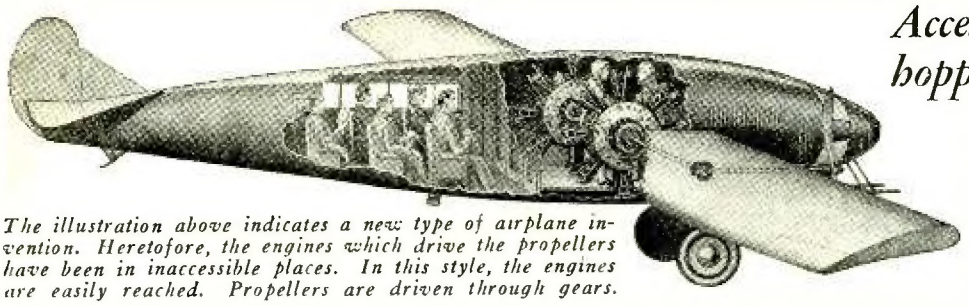


The illustration above indicates a new type of airplane invention. Heretofore, the engines which drive the propellers have been in inaccessible places. In this style, the engines are easily reached. Propellers are driven through gears.

Accessible Motors and Grasshopper Legs for New Aircraft

Inventors Are Busy Designing New Types of Aircraft with the Purpose of Minimizing Some Inherent Disadvantages

WHEN INVENTORS TAKE WINGS

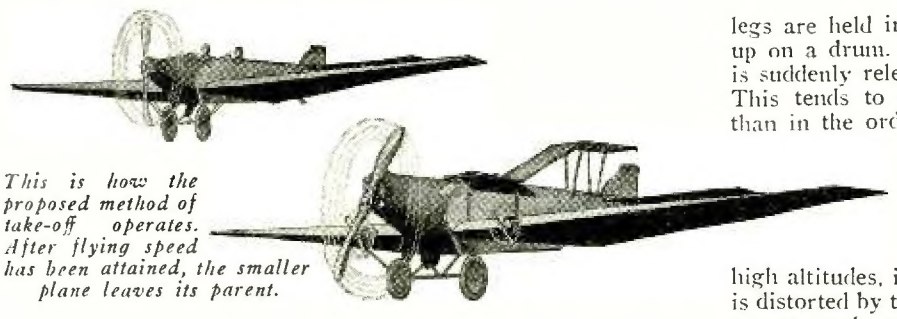
WHILE many new patents are issued every week by the United States Patent Office, on different styles and types of aircraft, and while some of these inventions are ludicrous and entirely inoperative, there are other newer developments which are worthy of more than passing consideration. Only a few of these very recent departures are presented on these pages. They have all been recently patented, and therefore will give the reader an idea of the trend of thought among inventors who are making efforts to put aviation into that field of repute it so richly deserves. Even a cursory glance at the illustrations on these pages will convince the reader that the prime object among inventors is to increase the safety of airplane flight.

Airplane Safer Than Auto

ACTUAL figures have already shown that airplanes are much safer than even the automobile. There are less airplane accidents than there are automobile accidents, if the number of fatalities are compared with the number of miles of actual airplane or automobile travel. The reason for this is obvious. The individual operating a plane is a licensed pilot who has demonstrated his ability to handle his ship to a higher degree than a man is required to demonstrate his ability to operate an automotive vehicle. A short drive of several blocks can never prove the value of a chauffeur, yet that is all that is required in order to give him a license. But even a short airplane flight demonstrates the ability of the pilot. Furthermore, air lanes are not as congested as are automobile roads. The aviator has countless levels at which he can proceed. The automobilist has but one. In addition, the airplane can move to the right or left whenever and wherever required; the speed is practically limitless. The automobile has but a narrow channel cut out for itself.

Engines Easily Accessible

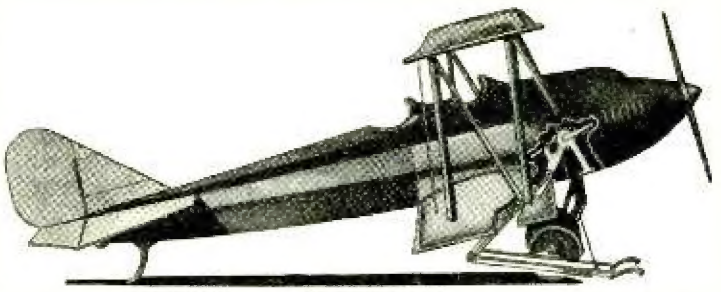
ONE bone of contention with aviators is the possibility of engine trouble. This may be due to any one of a countless number of causes, spark plugs fouling, valves sticking, breakage of parts, clogged gas lines, generator trouble and what not. But airplane engines have always been placed in such positions that they are practically inaccessible to the pilot, or to his mechanic. In the sheerest emergency, he may be able to crawl out on the wing and make adjustments, but he could not make any major repairs in such a precarious position. In order to obviate this difficulty, Robert V. Morse has invented a system which is to reduce the head resistance of the airplane by placing the engines within the fuselage, and which will increase the ease of handling by locating the heavier motor weights near the center of gravity of the airplane, and further facilitate repairs on airplane engines, even while the plane is in flight. As is indicated by the drawing at the top of this page, the engines themselves are housed within the fuselage and are cooled by air forced around the cylinders through suitable passages arranged in the fuselage. There is enough space between the two engines to permit the mechanics to work upon them. The engines themselves are connected with the propellers through spiral bevel gears. The shafts run in the space between the surfaces of the wing, and consequently offer no air resistance. They can be lubricated from the engine room. It is thought that any losses in gearing will be more than overcome by the decrease in head-resistance when the engines are placed as indicated, and the other advantages are, of course, self-evident.



This is how the proposed method of take-off operates. After flying speed has been attained, the smaller plane leaves its parent.

Grasshopper Legs for Aircraft

A DEVICE characterized as an automatic ground release for airplanes is an invention of Charles D. Carey of Channing, Michigan, and presents the second of the newer ideas. There are two illustrations showing this type of aircraft, the first with the legs folded up preparatory to leaving the ground, and the second, a moment before the airplane actually breaks contact with the earth. As will be observed in the illustration, there are a pair of members which fold up like grasshopper legs. The distal ends of these members are provided with claw-like arrangements to grip the ground. The legs are held in a folded position by means of a cable wound up on a drum. When the ratchet holding this drum in check is suddenly released, the springs extend the leg-like structures. This tends to get the plane into the air more expeditiously than in the ordinary manner, because it lifts and at the same time shoots the plane forward.



This particular type of take-off device might be characterized as being a grasshopper action for airplanes. Note the legs which grip the ground, extending from beneath the fuselage. Then see illustration at the right

Heater for Aircraft Wings

IT is a well-known fact that in the navigation of airplanes in cold weather or at high altitudes, it frequently happens that the form of the wings is distorted by the accumulation of frozen moisture (ice, sleet or snow) on the outer coverings of the wings. The accumulation of moisture necessarily adds to the load to be sustained by the ship, and tends to force it down. Furthermore, in the case of the airplane, not only is the accumulation injurious because of the added weight, but a much more serious effect is produced. The ice and snow forms on the leading edges of the wings, thus destroying the proper curvature or air-foil section, and in consequence interferes so with the lifting power

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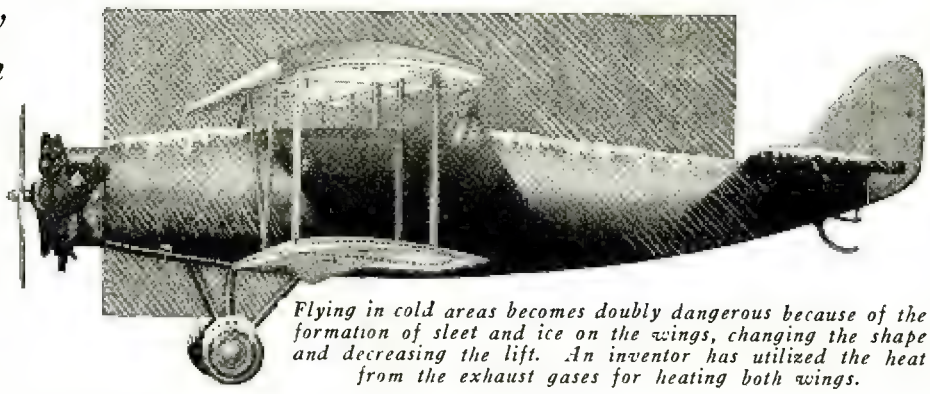
Heated Wings and New Tandem Take-Off System

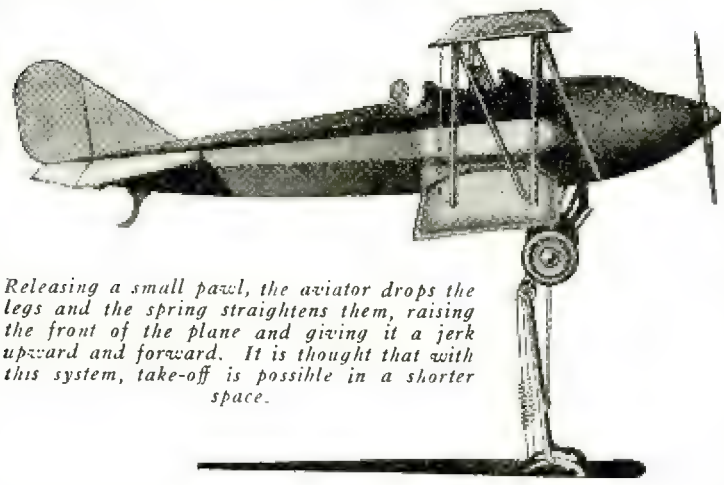
The Latest Patents Indicate Some Unique Systems Which May Revolutionize the Aircraft Industry

By JOSEPH H. KRAUS



Flying in cold areas becomes doubly dangerous because of the formation of sleet and ice on the wings, changing the shape and decreasing the lift. An inventor has utilized the heat from the exhaust gases for heating both wings.

of the wings as to make the craft incapable of remaining in the air. Even though the weight of ice might be insufficient to overcome the flying qualities, the accumulation of ice distorting the wing surface effectually destroys the lift. In order to prevent such conditions, Mr. Aristides S. Carousso of Flushing, New York, recently took out a patent on a heater for aircraft wings, so arranged that the heat from the exhaust of the engine would pass through the interior of the wings before exhausting into the air. The wings are so arranged with suitable baffles that the exhaust gases must pass completely through the wings before they are permitted to escape into the air, and then the escape into the air is arranged in such a manner that it offers no resistance to the progress of the ship, and serves to further heat the trailing edge of the wings. As near to the trailing end as conveniently possible, a series of small nozzles are located on the wing so that the gases must pass through these nozzles to find themselves directed partly against



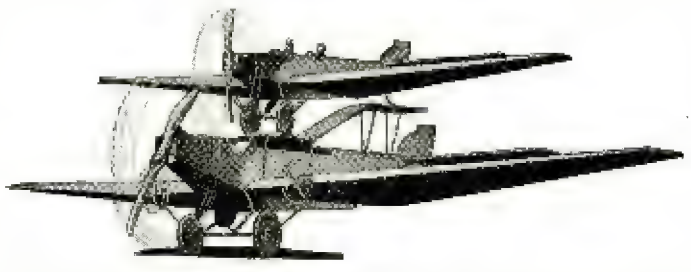
Releasing a small pawl, the aviator drops the legs and the spring straightens them, raising the front of the plane and giving it a jerk upward and forward. It is thought that with this system, take-off is possible in a shorter space.

the trailing edge, warming this trailing edge and thus melting the snow or sleet formed thereon. It has been frequently conjectured that the reason for failure of most transatlantic flights was the formation of sleet and snow on the wings. Whether or not this is so will only be learned after some pilot who has started out across the ocean is forced down and is rescued from the deep. Nevertheless, the suggestion made by Mr. Carousso is not at all impractical, and might be used to advantage on some of our larger craft intended for transatlantic voyages, for establishing new altitude records, and for operation in the colder climates.

Double-Decker Airplane

HUGO JUNKERS, the well-known German aeronautical expert, has just received a patent for an invention which covers a means for the starting of aircraft. In the past, attempts have been made to get heavily loaded airplanes off into the air by having an extremely long runway, or by having this runway in an inclined position so that the propeller can accelerate the speed of the ship rapidly. Even so, many attempts to get off into the air with heavily loaded machines have met with failure. Other suggestions have been made to the effect that the flying machine be placed on a rapidly moving motor truck, or on a slide which is to import as much initial momentum as possible. These starting means add an additional accelerating power to that created by the power plant of the machine, and in this way the velocity necessary for floating the ship in air can be imparted in a comparatively short run. However, these starting methods have many drawbacks in that they do not usually accelerate the ship to the desired speed and as a result the airplane drops a short distance before it takes off, hence they cannot be used where it is required to lift the vessel high enough to permit it to rise above obstacles in its path, such as, for example, trees, telegraph wires, and the like, which may be near the starting point. Another very important objection to the use of catapult-like devices is the fact that in heavily loaded machines, such a quick start is particularly difficult to attain, and the strain on the machine itself is very great. Accordingly, Mr. Junkers developed a platform which is to be mounted directly upon an airplane capable of sustaining a heavy load. The plane for the proposed long flight, after being fully fueled and made ready, is lifted into the air by its mother ship. The mother ship can easily sustain the load. After a high enough altitude is reached, as great a flying speed as possible is obtained by the mother ship, with the propeller of the smaller, heavily loaded plane also helping to drive the vessels forward. The smaller airplane can separate itself from its auxiliary craft as soon as the supporting surfaces or wings of this craft have attained the lift required for free flight. Thus to illustrate simply what would take place on a plane made ready for, let us say, a transatlantic hop, we would find that this is first mounted on top of another plane, such as a trimotored bomber. Everything is made ready, the smaller plane fully loaded with gasoline and supplies, and the larger plane carrying but one pilot and just enough fuel to produce the necessary initial lift and short flight. The big plane requires but a short runway. Its large wings are capable of sustaining it at a reduced speed, so it is with ease that the two ships are lifted into the air. As the mother ship circles the field several times and increases its speed, the pilot of the transatlantic plane soon begins to realize that his machine is capable of supporting itself, he gives his motor the gas, and spins off, leaving the mother ship to come to the ground again, while he continues on his long trip.

This is another way of getting around the problem of refueling a plane in air, by which system long distances could also be covered without requiring extraordinarily long runways or without awaiting the most favorable winds. It presents an additional and distinct advantage over the refueling problem in that a one-place plane can be lifted into the air, whereas the pilot of the same one-place plane would find it difficult to refuel in air. It also is beneficial to those pilots who have planes in which the wings have been cut down as small as possible, so as to produce the greatest (*Continued on page* 183)



A plane fitted for a long flight often finds it difficult to get off the ground. In order to facilitate this, the smaller plane is mounted on a special platform built on top of a heavy lifting plane, is taken into the air, and released there.

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Is a COLLEGE EDUCATION worth while?

Opinions of the World's Foremost Leaders in Arts, Sciences and Industry are Presented Here.

David Belasco was born on July 25, 1859. He is a graduate of Lincoln College and is now owner and manager of the Belasco Theatre in New York. He was formerly the stage manager of Baldwin's Theatre, The Grand Opera House and the Metropolitan Theatre, San Francisco. He was also stage manager of the Madison Square Theatre during the years 1880 to 1887 and later of the Lyceum. As the author of many plays, many adaptations and the sponsor of many of the world's most famous stars, he needs little further introduction.

One Can Make Good Without College Training

David Belasco, the world-famous dramatist and producer, writes on the subject of the value of a college education, as follows:

COLLEGE, or the Great University of World Experience. Which?

This question, asked me by SCIENCE AND INVENTION Magazine, is best answered, to my mind, by the single word "Either."

To explain: I consider the college education absolutely indispensable to the young man or young woman destined for one of the technical professions. I consider it a wonderful adjunct in mind and personality building for any boy or girl, provided it can be had without too great sacrifice, but—

The Great University of World Experience is a splendid Alma Mater if the individual's life work is not of a technical nature, or if the college education involves demands upon others, or on the individual personally, past the value of the training received during the four years of college life. I believe the boy who permits poor parents to go without everything but the bare necessities of life in order to give him a college training, pays too high a price for what he receives in return.

Scores—hundreds—have asked me if I believed a college education was essential to stage success. Here again the same rule applies. If a classical education is obtainable without too great a sacrifice, then it is desirable, always provided the potential player plans to become an interpreter of the classical roles.

But I have known men and women, almost unlettered, who have made superb stage successes, and at the same time college graduates who flunked miserably as Thespians despite the best of training.

I believe a college course, utilized to its fullest advantage, adds immeasurably to poise, confidence and latent ability of the individual. But I also believe that, if talent exists within the individual, the Great University of World Experience is an equally good teacher provided the quality of ambition is there.

The latter statement demands some elaboration. I believe each of us is cast in a mold for a specific purpose; that each has dormant within him the germs of success in some especial line. Some require "book education" for the development of this bent; others need but experience to complete their qualifications for the life-task. For the latter, one would be silly to demand college training.

Is a College Education Worth While?

SOME time or other in the lives of all of us, this question crops up. We must weigh it carefully and give it due consideration.

Perhaps we would like to go to college.

Perhaps we have sons or daughters who we would like to send to college.

Perhaps they would care to go, but we question the value of that college education.

The most logical step to take would be to ask someone who knows.

This publication has tried to make it easier for you, and before the next college term opens, and prior to matriculation, we will present to you the opinions of the leaders in industry, arts and sciences on this subject. The determination of the value of the college education we will leave to you.

If perchance you care to say something on the subject, remember that there is a Readers' Forum Department for just such comments.

Actually the problem resolves itself into the question: "What is to be done with the training after it has been bought and assimilated?" Technical professions indicate the college training as surely as flowers indicate the presence of sunshine and rain.

But what of the sculptor, the artist, the musician, the inventor, whose mind runs toward mechanical things? Take the latter. Is it not fair to assume that four years spent in the midst of the sort of machinery which intrigues his interest would be more effective than a general college course? I believe so, even though some will say: "But even then he will have to learn certain rules of physics and dynamics." True enough, he will, but *everything* he learns during that period will be in the line of his work.

In the college he will be required to learn many things of little use to his somewhat "single-track" mind.

And while we are on the subject of minds. There are certain mentalities which absorb knowledge as a sponge takes up water. I am not too sure but that such minds are better in the Great University of World Experience than in the conventional seat of learning.

I am not an iconoclast in educational matters; I am merely practical. Given funds, leisure, a certified future, every young man and woman would do well to avail themselves of the opportunity for the higher education.

But given a definite and not too technical urge for a life work and the necessity for individual earnings at the earliest possible moment, I would advise The Great University of World Experience.

Its alumni have made good.

College Education, If Backed Up, Is Worth While

Pierre S. du Pont, whose name appears in the press almost daily, has answered our call in the following manner.

AS to the value of a college education, I do not think I am particularly qualified to speak in an article such as you suggest. I thoroughly believe in college education for those who are qualified to benefit by it. Not every young man, or woman, absorbs learning as readily from books, lectures, etc., as he does from work at some practical employment. Those who have this characteristic should not take college education nor should they try for it. It is a mistake to think that the mere statement, "I have had a college education," will help in the battle of life. It is necessary to back up the statement with a practical demonstration of added capacity through having taken the college course. I am such a believer in a college education as to overlook a few ill effects that may be

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Pierre S. du Pont was born in Wilmington, Del., on Jan. 15, 1887. He is a graduate of the National Institute of Technology and is Chairman of the Board of E. I. du Pont de Nemours & Co., internationally famous for the explosives they manufacture, and Chairman of the General Motors Corp., Director of the Chatham and Phenix National Bank and a Director of the Philadelphia National Bank. He is also a Director of the International Corporation of New York.

quoted with reference to those who idle away time and fail to make a serious business of acquiring learning. Such men are in the minority and, although they make a show disproportionate to their numbers, the incident of their failure is not a material one.

Is Advantageous Yet May Be Detrimental

Howard T. Barnes, Professor of Physics at McGill University, writes:

I HAVE considered a college education worth while in the case of my two sons, one of whom is a Doctor of Philosophy at McGill and now is a Research Fellow in the Royal Institute, London; and the other a Doctor of Science at Harvard University and Tutor in the Biological Department. It is very evident that I regard a college education worth while for my own sons.

I do not know that I am competent to write upon this subject as a general formula for all young men, for I feel that there are a great many going to college who should not be there. In many cases, a college education is a detriment to a career; on the other hand, I think that a general college education is a distinct asset. I regard the whole subject matter as being of more or less individual importance and the whole thing depends upon factors of heredity, environment and opportunity.

You do not comment on the question of a college education for women. As I have a daughter who is contemplating college next year, I have given this matter some attention, but I do not stress the importance of a college education for women, in fact, I am rather inclined to discourage it. Such higher education should be distinctly elective and not encouraged. I feel myself quite incapable of judging for the great bulk of our young men and women and feel strongly it is a matter of family concern.

College Education Series

This is the first of a series of opinions on the value of a college education.

The leaders who have expressed their opinion on this subject are of national and of international repute. The following two issues of this magazine will contain continuations of the subject.

Captain William Beebe is an ornithologist and author. He was born in Brooklyn, July 29, 1877. He is at present carrying on researches for the New York Zoological Society at Nonsuch Island, Bermuda. He has a B.S. degree from Columbia University, where he took a post-graduate course, and also an Sc.D. degree. Since 1898 he was curator of ornithology at the New York Zoological Society. Also, since 1899, director of the department of Scientific Research. His writings are voluminous. At present he is the Director of the Bermuda Oceanographic Expedition.

Photo by Bachrach

College Teaches the Habit of Study

William Beebe tersely replies to our letter as follows:

THE question, "Is a College Education Worth While?" crops up periodically and in the end gets nowhere for the very excellent reason that in the long run there is only one factor and that is individuality. Like liquor, or strawberries, or athletics, what is one boy's boon is another's catastrophe. The habit of study is to me by far the greatest help I got from my college career.

College Has Advantages

C. G. Abbot is the Secretary of the Smithsonian Institute. He replies to the question as to the value of a college education as follows:

CAN one be well educated without going to college or scientific school? Certainly, if he is determined to be. He can buy or consult in libraries the same books, and consort with clever people. In short, he may make for himself the

(*Continued on page* 187)

H. T. Barnes has done much original work on the thermiting of icebergs. Several months ago an article by him appeared in SCIENCE AND INVENTION Magazine. *As a professor at the McGill University, his comments should be of interest to the readers inasmuch as he comes in daily contact with hundreds of college students.*

Charles Greeley Abbott was born May 31, 1872. He is a college educated man, having the degrees of S.B., S.M., and D.Sc. From 1895 to 1907 he rapidly rose through various positions in the Smithsonian Institute. He was engaged continuously in original researches in the solar radiation and conducted expeditions to observe total solar eclipses. He has many medals to his credit for original work done along these lines.

Photo by Bachrach

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How Much Power to Start a Train?

By EDWARD C. SCHMIDT,
Professor Railway Engineering,
University of Illinois

A Popular Exposition Dealing with the Power of Locomotives and the Resistance of Trains

Fig. 4—The famous 20th Century Limited is shown above. An average train consists of twelve cars of 80 tons each. The above graph shows the power required to keep the 20th Century in motion, at 60 miles per hour; and also power required to start it.

DURING its century of development, the tractive force of the steam locomotive has increased a hundredfold. The horizontal force which it exerts upon its train is about one hundred times as great as it was in 1829, when on the Liverpool and Manchester Railway in England it first demonstrated its practicability as a means for operating railway trains.

A typical modern freight engine, weighing with its tender about three hundred tons, could haul today on level track a train weighing fifteen thousand tons (50 times its own weight), and on the moderate grades ordinarily encountered on American railways, it actually does haul trains which weigh five thousand or six thousand tons—or about twenty times its own weight.

Surprise is occasionally expressed at this great disparity between the weight of the locomotive itself and the weight of its train; but a little reflection upon some of our everyday experiences will help to dispel any feeling of mystery in this fact. A small boy can drag on an ordinary floor a sack of flour weighing as much as himself; and on a sled on the ice he can draw several times his own weight. A man of ordinary strength has little difficulty in moving a wagon weighing eight or ten times his own weight; and a good team of horses, weighing together about three thousand pounds, can start and easily draw on ordinary pavements loads as great as 33,000 pounds (11 times its own weight). The force required to move any weight horizontally depends primarily upon how it is supported—whether on wheels or otherwise; and the force required to move any wheeled vehicle depends upon the character of the bearings, the size of the wheels, and the smoothness and hardness of the surface on which they roll. For each set of conditions there is a fairly definite relation between the weight and the force required to move it. For railroad trains this relation has, in the course of time, come to be pretty well defined.

For freight trains composed of cars such as are in use on the railroads of this continent, the force required to move a train on *level* track at *uniform* speed is shown by the curves of Fig. 6. Low winter air temperatures or strong head winds will increase this force; but for the conditions prevailing in moderate weather Fig. 6 is substantially correct for all American freight trains. In the figure the vertical distances up to the curves represent the net train resistance, that is, the horizontal force required to move the train at uniform speed on level track, this force being expressed in pounds per ton of train weight. The horizontal distances represent the train speed, expressed in miles per hour. The upper curve A gives the relation between train resistance and speed for cars weighing about twenty tons each, which is about the weight of the ordinary empty freight car. The middle curve B relates to trains in which the average weight of the cars and their lading amounts to forty-five tons, which is nearly the average gross weight of all cars running day by day on American railroads. The lowest curve C applies to trains in which the average weight of the cars is about seventy-five tons which is, with a few

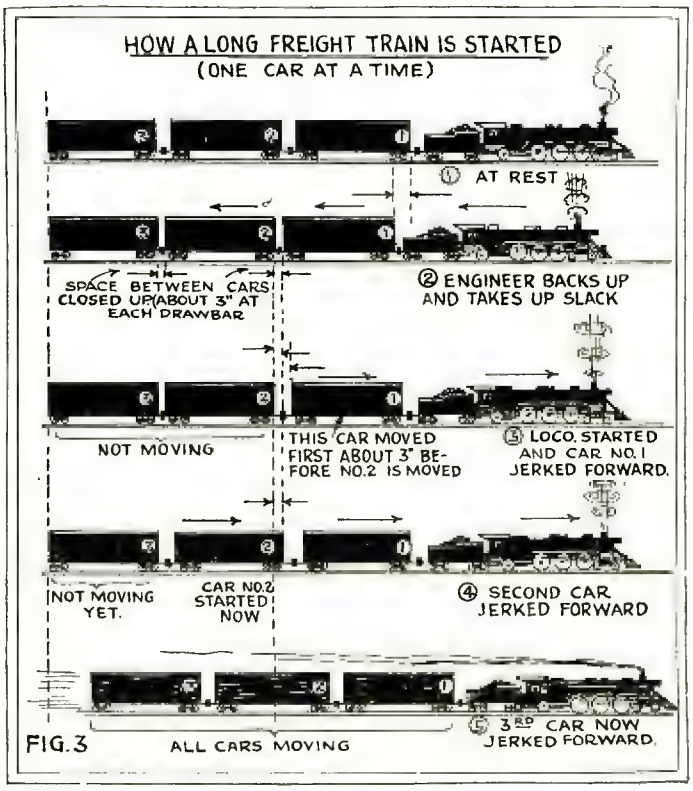
HOW A LONG FREIGHT TRAIN IS STARTED
(ONE CAR AT A TIME)
① AT REST
SPACE BETWEEN CARS CLOSED UP (ABOUT 3" AT EACH DRAWBAR
② ENGINEER BACKS UP AND TAKES UP SLACK
NOT MOVING
THIS CAR MOVED FIRST ABOUT 3" BEFORE NO.2 IS MOVED
③ LOCO. STARTED AND CAR NO.1 JERKED FORWARD.
NOT MOVING YET.
CAR NO.2 STARTED NOW
④ SECOND CAR JERKED FORWARD
⑤ 3RD CAR NOW JERKED FORWARD.
FIG.3
ALL CARS MOVING

Fig. 3—The above illustration shows how a long freight train is started by moving one car at a time. The first car moves about three inches before the second is started.

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exceptions, about the maximum weight now encountered in freight service.

Considering the curve B we see that for trains composed of cars weighing about forty-five tons each, it requires a force of thirty pounds for each ton of train weight in order to start the train in motion; that is, for a train weighing five thousand tons, a force of one hundred and fifty thousand pounds would be required to move the train from a standstill, assuming that it were necessary to set all the cars in motion simultaneously. There are very few locomotives that can exert so great a pull as one hundred and fifty thousand pounds, and if it were necessary to set all cars in motion at once, a train of this weight (which is not uncommon) could not ordinarily be started. Fortunately, however, a freight train need not be started in this way; *it actually is started one car at a time.*

In all cars the connection between the drawbar and the car body is not rigid, but is made by means of a group of springs and other moving parts, which permit a motion of two and three-quarter inches between the drawbar and the car, before the drawbar is fully extended. In a train of coupled cars, therefore, the first car, since it is connected to the second through two drawbars, may move twice this amount or five and one-half inches before the second car is forced into motion. Advantage is taken of this fact in starting a heavy train. In order to start, the engineer first backs his locomotive up against the train so that this motion in the draft gears is nearly all taken out or compressed, a process which is called "taking up the slack." In this process, obviously, the backward motion is communicated successively from one car to the next.

With the slack thus taken out and the train "bunched," the engineer then quickly starts the locomotive forward and exerts on the first car a pull or jerk which, because of the slack in the draft gear, causes the first car to move forward, under ordinary circumstances, about three inches, before it exerts enough force to start the second car. Having moved this distance, the first car then transmits to the second a jerk, which puts the latter in motion and this action is repeated from car to car throughout the train, until all cars are moving.

The train consequently is actually put in motion car by car, requiring a very much smaller pull from the locomotive than the one hundred and fifty thousand pounds which would be necessary if all cars had to be started at once. Once the train is in motion its resistance decreases very suddenly, as is indicated in Fig. 6. Recurring to curve B, we find that as the train starts, the resistance falls abruptly to a minimum value

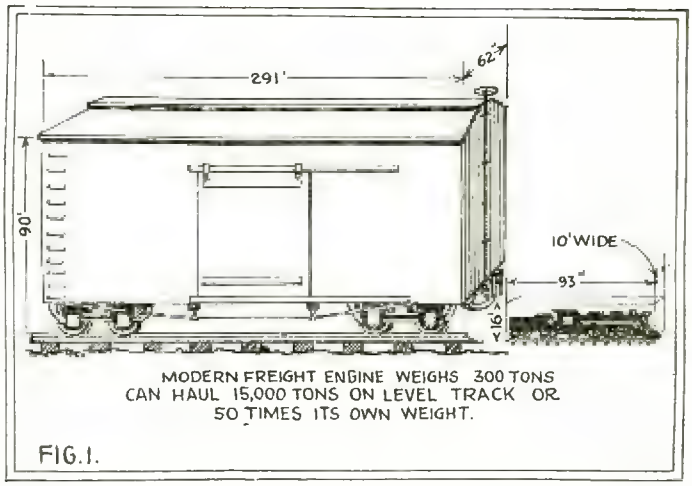

Fig. 1—A modern freight engine weighs 300 tons and can haul 15,000 tons on a level track, or fifty times its own weight. The above illustration shows this by comparison of sizes.

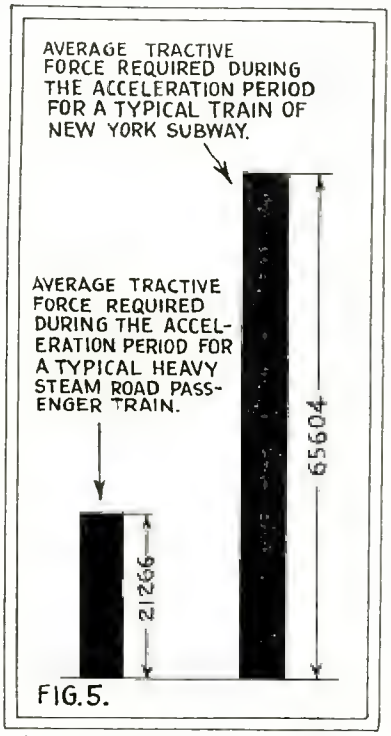
AVERAGE TRACTIVE FORCE REQUIRED DURING THE ACCELERATION PERIOD FOR A TYPICAL TRAIN OF NEW YORK SUBWAY.
AVERAGE TRACTIVE FORCE REQUIRED DURING THE ACCELERATION PERIOD FOR A TYPICAL HEAVY STEAM ROAD PASSENGER TRAIN.
65604
21266
FIG.5.

Fig. 5—The average tractive force for acceleration.

of four pounds per ton, at a speed of about three miles per hour; from then on the resistance increases gradually to 7.3 pounds per ton at 40 miles per hour. Similar variations occur for the lighter and the heavier cars, as disclosed by curves A and C in Fig. 6.

The relationship between the pull developed by a locomotive and the speed at which it runs is also fairly well defined. For a freight locomotive such as has been referred to, namely, the so-called Santa Fe type, a machine with ten driving wheels and weighing with its tender about 300 tons, the tractive force available at the rear of the tender on level track will be as shown by the curve of Fig. 7. At starting, such a locomotive can exert a pull of 74,000 pounds and the pull can be maintained at substantially this figure, while the speed increases up to about four miles per hour; beyond this speed, however, the pull begins to fall off, due to the fact that at higher speeds the engine pistons make more and more strokes per minute and consequently demand more and more steam. Beyond a speed of about four miles per hour, the boiler is no longer able to meet the increasing demand for steam and the engineer is compelled to shorten the cut-off —that is, he must so manipulate the mechanism controlling the valves that the cylinders, instead of being completely filled with steam at boiler pressure, are only partially filled, and the steam is allowed to operate for part of the stroke by expansion. *This reduces the average steam pressure in the cylinders and makes a corresponding reduction in the tractive force.* As the speed is still further increased, the cut-off must be again decreased, and we therefore find that the pull exerted by the locomotive diminishes steadily as indicated in Fig. 7. The relationship between pull and speed shown in this figure is fairly typical of this relationship for all modern locomotives.

With such information about train resistance and locomotive tractive force as is contained in Figs. 6 and 7, we are able to determine the weight of train which can be hauled by a given locomotive—a process which is usually called locomotive tonnage rating. This train weight is always limited by the maximum or ruling grade on which the locomotive operates. Ruling grades vary in steepness up to about two per cent; a two per cent grade being one in which the track rises vertically two feet in one hundred feet of track length. In other than mountainous or very hilly territory, the ruling grades on first-class American railroads are generally from one-third per cent to one-half per cent.

If we assume that the Santa Fe type locomotive above referred to is to operate on a ruling grade of one-half per cent, we may determine the weight of its train as follows. We may assume first that the speed at which it is desired to pass the grade is ten miles per hour. Referring to Fig. 2, we see that at this speed on level track the (*Continued on page* 184)

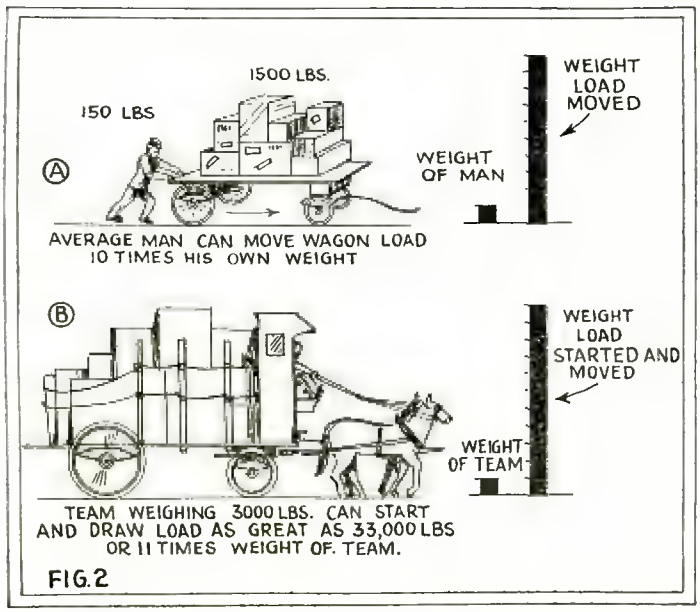
1500 LBS.
150 LBS
Ⓐ
WEIGHT OF MAN
WEIGHT LOAD MOVED
AVERAGE MAN CAN MOVE WAGON LOAD 10 TIMES HIS OWN WEIGHT
Ⓑ
WEIGHT OF TEAM
WEIGHT LOAD STARTED AND MOVED
TEAM WEIGHING 3000 LBS. CAN START AND DRAW LOAD AS GREAT AS 33,000 LBS OR 11 TIMES WEIGHT OF TEAM.
FIG.2

Fig. 2—An average man can move a wagon load ten times his own weight, while a 3,000 pound team can draw the load indicated.

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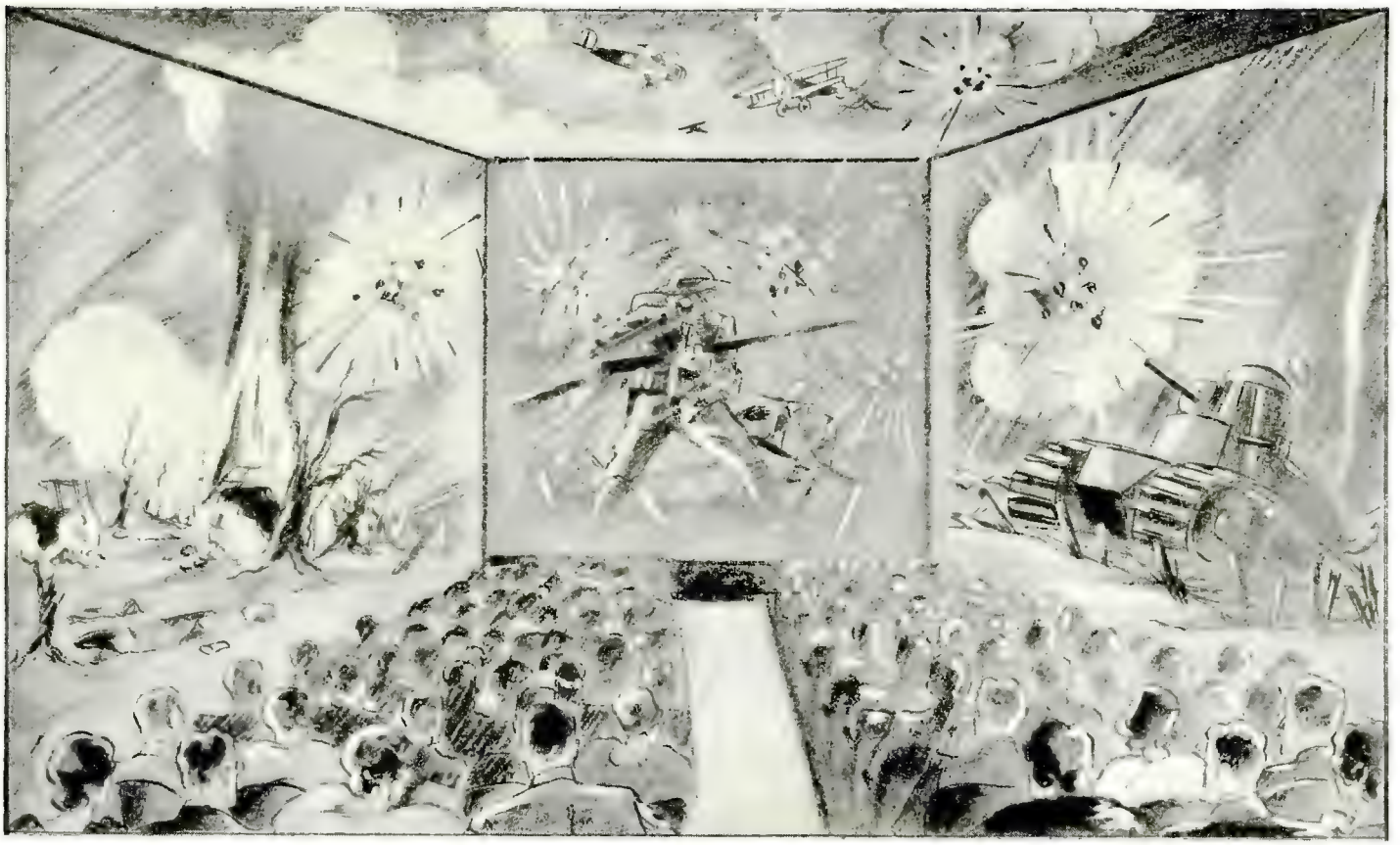


A four-screen theatre is shown above. Films can be projected simultaneously on all screens and the interior can be changed instantly. The screens on the sides and top are black. The spectators will all sit on the same plane with seats sloping forward.

A Four-Screen Theatre

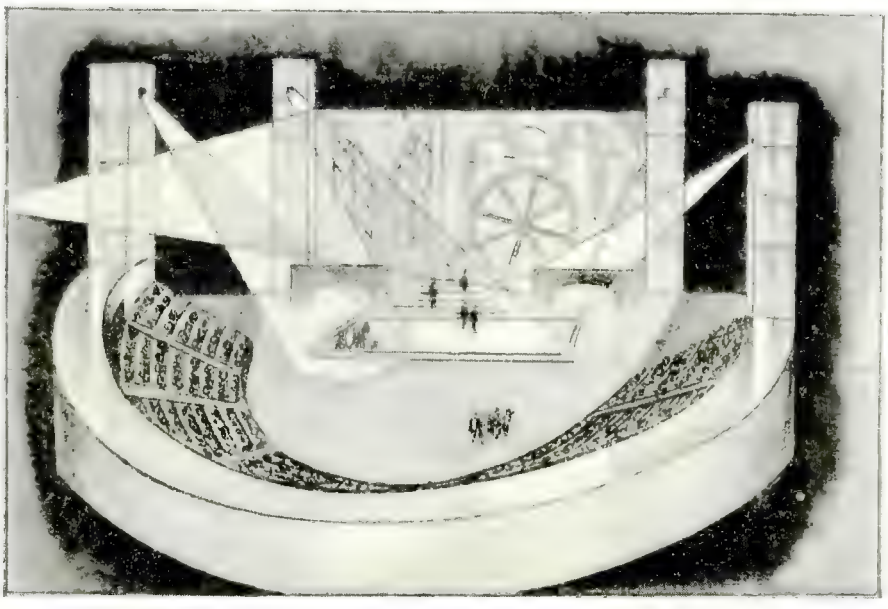
Art Reaches High Level in New Moving Picture Houses

A NEW moving picture theatre is to use four screens. Films can be projected simultaneously and the whole interior architecture of the house can be transformed in a flash, to a setting appropriate for the picture being shown. The spectators will all sit in the same plane. The interior will resemble the inside of an ordinary camera and the whole funnel-like theatre will be one huge four-sided screen. Projecting from each wall and the ceiling are black screens. The top screen slopes down to meet the top of the stage arch, back of which is a white screen. This is saucer-shaped and rounded, in order to correct the angle of vision for those seated in various parts of the house. The picture can be thrown on all four screens, truly *immersing* the audience in the drama. In a war film, such as that shown, it would be possible to have airplanes flying overhead with the personal drama being enacted on the saucer-shaped screen and lines of advancing tanks and men on the side screens.

It would also be possible by throwing slides on the auxiliary screens, to transform the whole interior architecture of the theatre in a moment.

Outdoor Theatre

THE German magazine *Wissen Und Fortschritt* describes a theatre built in the open in the form of a Greek arena. The spectators, without straining their necks, can see the surrounding hills as a background, and on the horizon the silhouette of a city, all of which provides excellent scenery. Enclosing the elliptical arena in the middle are two great columns. There are many rows of seats rising in curves, and if the act needs extra scenery, it is produced upon the stage itself. Extensive scenery and theatrical buildings are located on the terrace shown at one end. There are two towers at each entrance which rotate and are equipped with powerful spotlights used during night presentations. Both towers on either side of the stage support a screen for photoplays and also for the projection of scenery during the stage productions. As in the old Greek theatres, the stage and auditorium is virtually one.



The outdoor theatre built in Germany is illustrated above. There are many rows of seats rising in curves and the whole structure is built on the order of the old Grecian arenas. Large towers contain lights for night presentations.

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MODERN SPEED CARS

"El Pirata"—latest stream-lined Franklin speed model; custom body by Dietrich.

By H WINFIELD SECOR

Swiftness, Style and Comfort Embodied in Latest Automobile

IN keeping with our modern speed age, the designs of many of the cars of this year have changed considerably. A class of speed cars have been produced which enable the owner to travel at a rate of 100 or more miles an hour, in safety and comfort.

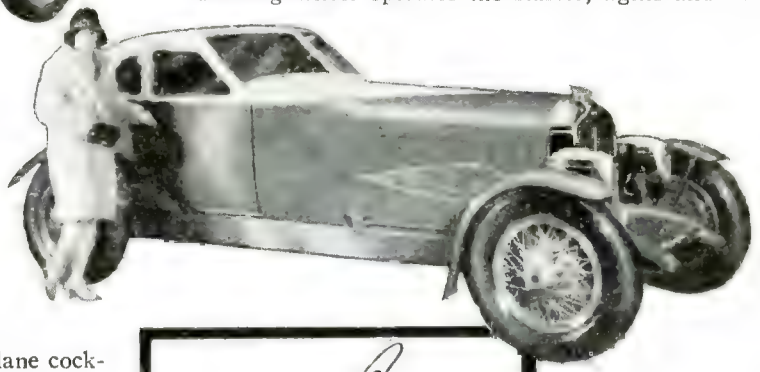
The photograph at the top of the page shows a Franklin car of this sort, with an aviation motif carried out in body design.

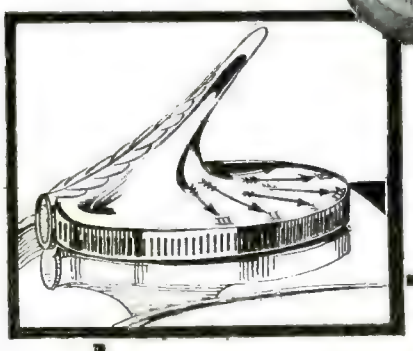
The photograph above shows one of the latest Dupont speed roadsters equipped with a 140 h.p. straight eight motor. At the left, is a two place Auburn cabin speedster, capable of maintaining a speed of 100 miles per hour, powered with a 125 h.p. straight eight motor. It is only 4 ft. 10 in. high and the body is made of aluminum material. The car with gas, oil and water included, weighs only 3,000 lbs.

The interior with its seat is fashioned to resemble an airplane cockpit; an aviation compass, and an inclinometer are included. An air cooled engine is used and the windshield is of non-shatterable glass. The Auburn cabin speedster shown weighs only 3,000 lbs. when loaded and the stream-line body and the pointed tail enable greater speed to be obtained. This car is only 4 ft. 10 in. high and has a wheel base of 120 in. It is equipped with a 125 h.p. straight eight motor. No running boards are used and the two seats are of the wicker basket airplane type. Windshields and windows are of laminated nonshatterable glass. An added feature lies in the fact that this car is sold after it has been broken in and each one has a plate on which is engraved its certified speed. Every model is officially tested at 100 miles an hour or better with speed verified.

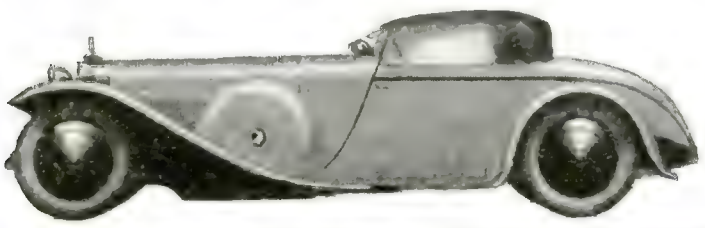
Another speed car shown is the Dupont, which is equipped with a 140 h.p. straight eight motor, the car developing a speed of 100 miles an hour or more. The body is of the stream-line type and the running boards are of a peculiar shape, as will be noticed in the photo. The automobile appearing at the bottom of the page is capable of doing 102 miles an hour and higher and is powered with a 6 cylinder engine having a brake horse-power of 120; when used with a compressor gives a horse-power of 180. Gasoline rate 2.4 miles per gallon. Long, semi-elliptical springs overslung in front and underslung in the rear make for greater riding comfort.

The small line drawings show several interesting accessories, the first being a sun dial radiator cap which is now employed on one of the modern cars. The second, is a novel neon light stop sign which is visible through rain, fog, dust and the exhaust. It is about 6 in. wide and 2 in. high and is placed in the rear window of the car. Heavy clips hold the tube in place, making it easily removable. The third illustration shows a step forward in simplified control. The single button placed in the center of the steering wheel operates the starter, lights and horn.





The three drawings at the left show a sun dial radiator cap, a neon light stop signal, and a single button control which operates the starter, lights and horn.



Left — Mercedes-Benz, one of the world's fastest sport cars, which is capable of traveling at a speed of 102 miles per hour.

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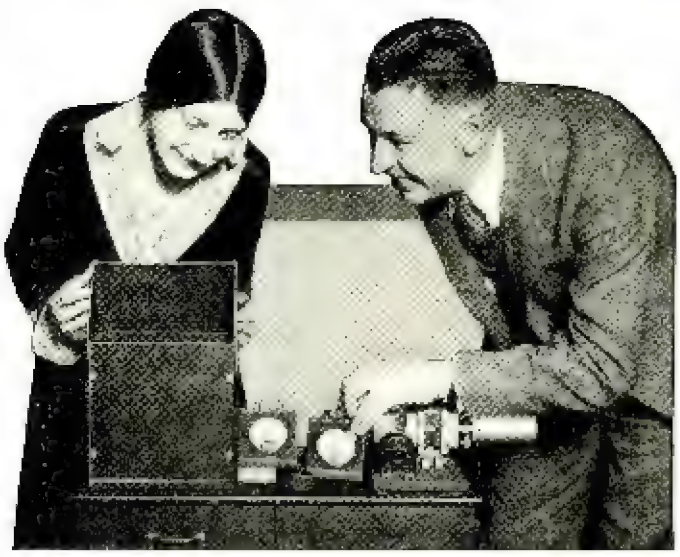
Radio and Talking Moving Pictures Are Expected To Be Revolutionized by Newly Perfected Sound Instrument

Physical Possibilities of a Voice Both from a Scientific and Musical Standpoint Can Now Be Ascertained by New Analyzing Device

Quality or Tone of the Human Voice Can Be Regulated According to the Desire of the Artist



In the above photograph Carl Rhodehamel, the inventor, is testing the voice of Miss Alba Cravero. The young lady is watching the pulsations of her own voice.

Sounds Can Be "Stored" and Telephone Conversation Recorded with Latest Machine of California Inventor

VOICE Analyzed and CHANGED

By CLARENCE EBEY

Miss Cravero is shown above tuning in on a radio broadcast of her own voice, recorded a few minutes previously.

THE perfection of devices which are expected to play an important part in radio and sound moving picture performances has been announced by the inventor, Carl Rhodehamel, of Oakland, California. Radio and moving picture artists will soon find it possible to select their style of voice as easily as they now don an overcoat. The new sound device will record and reproduce sound, as well as analyze the human voice and change it, if necessary.

There are four completed machines at present. One records the sound or voice; another enables it to be projected for study by physicists; the third reproduces it to a loud speaker after it has been recorded, and the fourth, called the "multi-voice," is able to change the quality or tone of the human voice, according to the desire of the speaker or to suit his or her personality. With these inventions, the physical possibilities of a voice can be studied and the pitch or tone changed at will.

A microphone is used in connection with the voice changing and recording instrument for picking up voice or sound.

The machine may be taken into the country to record the murmur of a purling brook, the whistle of a steamer, or the tolling of an old bell. That same evening these sounds may be heard in radio or other presentations. The cheers and yells at a baseball game can be recorded in the afternoon and broadcast at night. The recorded sounds could also be synchronized with film productions. Telephone conversations could be recorded and business men could talk into one of the machines and leave the record for a secretary to transmit, if it were necessary for them to be absent from the office. A man wishing to catch a train and having no time to wait for a long distance connection could simply leave behind one of these records for transmission later. The inventor prefers to keep the details of these machines a secret, but admits that they are different from any now in use.

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Unprecedented Speeds Soon Attainable by Rocket-Propelled Vehicles

Captain George White, former army man, with his rocket-propelled motorcycle which he successfully tested at the New York Velodrome. Note the 20 rockets.

This rocket motorcycle was successfully tried out by Herr Fritz von Opel, and was subsequently exhibited at the German Automobile Show, in Berlin.

Is Rocket Flying Possible?

Experimenters in foreign countries are the first to take advantage of rocket-propelled vehicles. System to be applied to speedy airplane travel. New field for experimentation is open.

The rocket car of Herr Volkhart at the beginning of a successful run, wherein it attained a speed of 60 miles an hour.

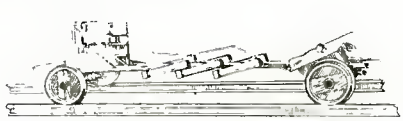
RECENT rocket-propelled vehicles of Von Opel-Sander and Eisfeld-Valier have gone to prove the possibility of rocket flying. The construction of such vehicles recently shows that the experiments are yet in their infancy but we must remember Count Zeppelin was regarded as a Utopian until duraluminum and proper motors made his dreams a reality and this may be taken as the status of rocket flying.

Today it is certain that numerous groups of investigators, single individuals and airplane firms, are earnestly concerned with the matter, while only six months ago but a small group were interested and worked on it. Fritz Von Opel must get the credit for the great propaganda, while at the same time Valier was at work with the Eisfeld German fireworks factory. This organization wished to improve rockets, so that with the smallest expenditure of material, the greatest possible efficiency would be obtained. The experiments with rocket-driven vehicles will be followed by attempts at flight. It appears that the matter is in serious hands. Regular records of the results are not being broadcast.

How a Rocket Works

THE explanation of the construction of a rocket can be taken from the diagram. A closed, cylindrical envelope of cardboard or metal is charged with powder solidly pressed into it. In small rockets a conical mandrel is introduced which, after the powder has been rammed in, is withdrawn, leaving a tapering hole. In larger rockets the powder is hydraulically pressed into them and a corresponding conical hole is drilled into it. This hole is of considerable importance. Its surface is called the burning area. Immediately after lighting the powder, the high gas-pressure is produced which, according to measurements, may run up to forty atmospheres. This pressure would burst the envelope except for the fact that there is an aperture provided through which the gases can stream. The nozzle, which is in the center of one of the flat ends, is called in German the "duese." The gas pressure in the interior depends upon the area of the burning surface and the size of the nozzle. The bigger the cavity, the larger is the burning area and the smaller the nozzle the greater will be the pressure. The pressure can be raised or lowered at will and in practice for best results, it is made so great as nearly to burst the case.

Immediately after igniting the rocket the high pressure in the conical cavity works in all directions, so that the pressure is reduced in the neighborhood of the nozzle, but the full pressure is exerted on the other end of the rocket and drives it forward. By proper provision, (*Continued on page* 187)



This is a diagram of Max Valier's rocket car which was adapted to a run on rails. The wing-like constructions were subsequently entirely omitted.

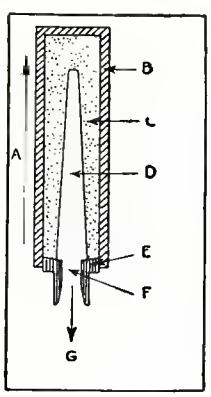


Fig. 2. The diagram at the left shows the construction of a typical rocket. A indicates direction of motion; B is the outside case; C, the charge of powder; D, the cavity; E, a muzzle of incombustible material, either metal or porcelain; F, the muzzle opening; and G, the direction of escape of the gases.

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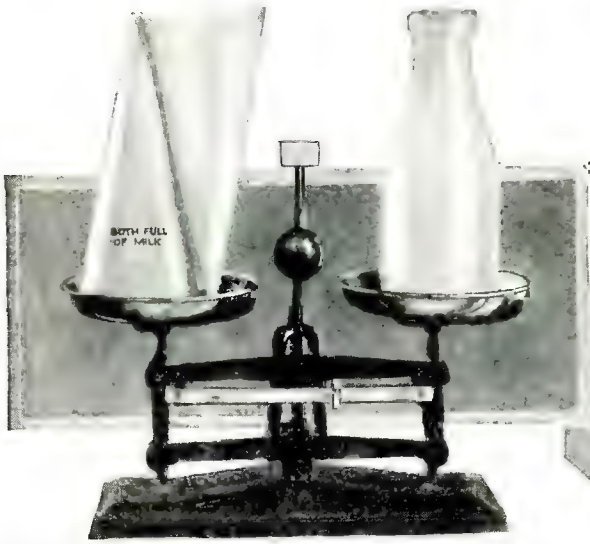
Paper Bottles Newest Type of Sanitary Milk-Dispensing Means, Now Being Substituted for Glass



The illustration above shows two of the new paper cones filled with milk and placed on a scale, together with a glass bottle of milk on the other side of the balance. The difference in weight between two quarts of milk and one bottle of milk is only seven ounces. The two quarts in the cones weigh 68 ounces, the milk in the bottle weighing 60.4 ounces. It is thus observed that bottles make up for a great deal of the weight. Imagine what this means to a company delivering a million quarts of milk a day. Photo at the right shows the paper carton in which milk is now being distributed.

MILK IN PAPER CARTONS

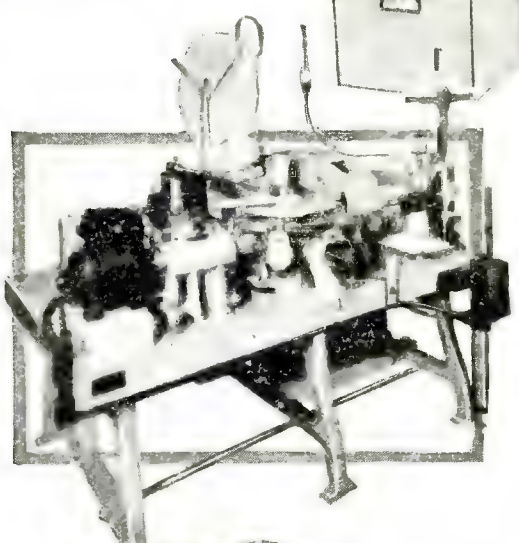
Containers are Sealed to Prevent Tampering

Milk in paper containers keeps longer, does not require icing, is easier to transport, much easier to handle, and less costly than bottled milk.

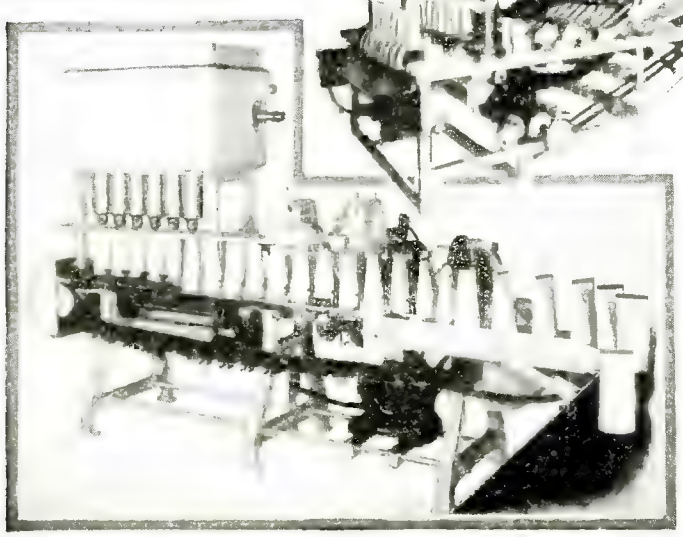
THE old-fashioned glass milk bottle, used for over 40 years in dispensing milk, may soon be a thing of the past. This milk bottle was large and heavy. It brought the milk to the family, and was later returned to the company again for sterilization and refill. Sometimes it was broken en route; at other times, it was used for storing liquids other than milk. These milk bottles cost about 4½ cents each. The price of a paper container is approximately ¾ of a cent, but, of course, the paper container can only be used once, whereas the bottle had a life of from four to six trips. There are, however, other advantages to this milk bottle made of paper, which are not possessed by the glass bottle. The first of these is a distinct benefit to the public, from the standpoint of sanitation. Each bottle is new. It is used by the consumer only once, and there is no possibility that dust can accumulate around the lip of the bottle. When the milk is poured from one of these cone-like paper containers, it issues from the mouth in a smooth stream and does not trickle down the sides of the bottle.

The paper carton in the center contains as much milk as the boxes at either end.

In the machine at the left, the cones are made in quart sizes. They then go to the paraffining machine.



The machine at the left dips the cones into hot paraffin, making them air-tight and water-proof.



This machine bottles the milk, and applies the seal to the top which makes it impossible for the milk to be tampered with, unless the seal is broken.

The milk, furthermore, can be put into the bottle at a temperature of from 33 to 35 degrees, which is well below the danger point. Bacterial growth commences at a temperature of from 40 to 50 degrees, and under ordinary circumstances, the milk in the glass bottles is at a temperature of from 40 to 43 degrees, but glass bottles must be packed with ice. It has been demonstrated that the milk in the paper containers does not require this ice packing. The retardation of bacterial growth by the lower temperature is also enhanced by the fact that the paper container does not transmit light. It has been demonstrated that milk will remain fresh in such a container twice as long as in glass, and it has been demonstrated that milk is sweet after five days when kept in the paper substitutes.

The metal clamp that firmly seals the top of the paper cone must be removed with an entirely different tool than heretofore. A fork or a knife was previously employed for taking the tops out of the ordinary milk bottles. Now, a pair of scissors does the work better than any other instrument. After the top is neatly cut off, the milk can be poured out but in order to close the bottle again, the top is folded over.

Milk with such containers weighs less and does not take up nearly as much room. The milkman is relieved of the duty of collecting bottles.

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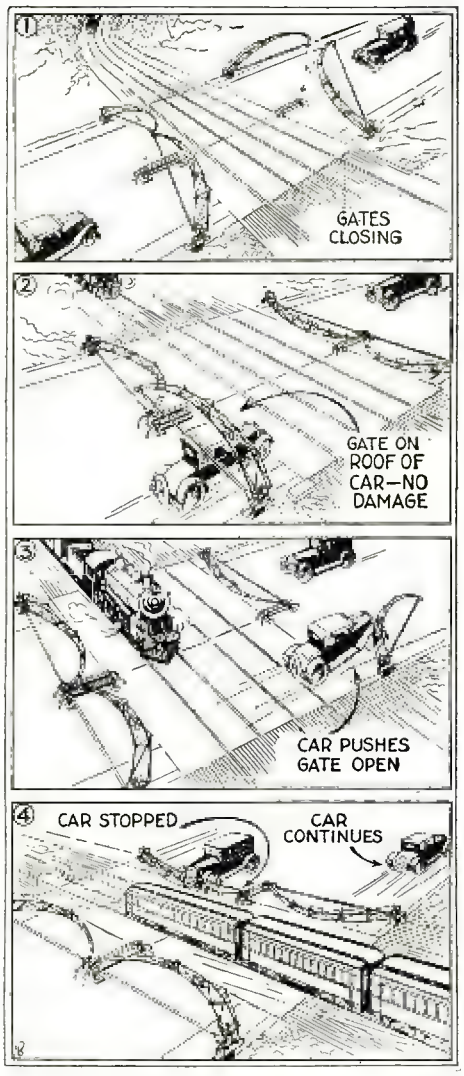
New Railroad Crossing Gate

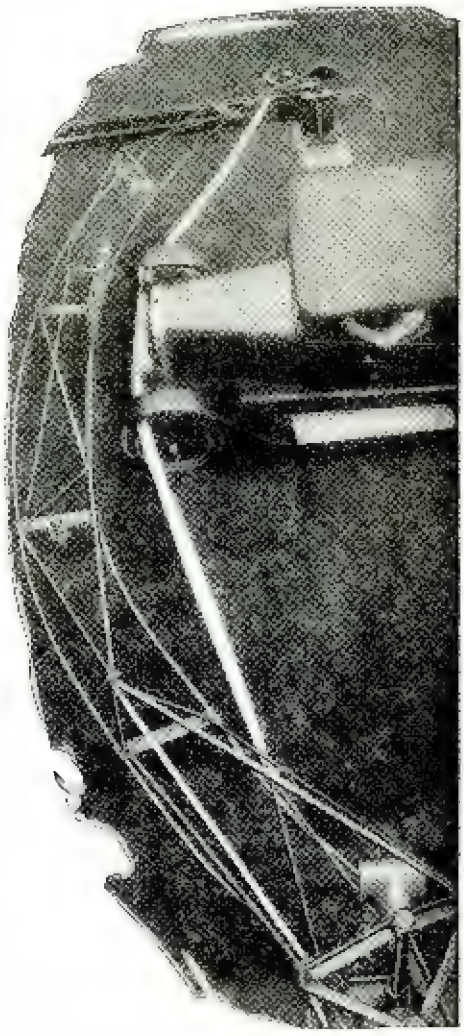
By N. C. McLOUD



The illustrations above show various stages in the operation of the new railroad crossing gate.

Violin Bow Gates for Crossings

UNIQUE and ingenious cushion gates for railway crossings have been recently designed and demonstrated, and have proven to the satisfaction of their inventors that they quite effectively prevent gate crashing. The new type of barrier is shaped like the bow of a violin, with a framework of spring steel representing the bow proper, and the "bow hair" takes on the form of two steel cables. The barrier rises and descends the same as do the gates now in use. Illustrations indicating the manner in which this operates are shown at the left. In 1, the gates are closing, in 2, the gates are almost down, but one of them has accidentally hit the top of a car passing under it. This car is permitted to proceed without damage. Striking the gate on the opposite side, the car passes on, also without damage to car, occupants or gate. A car traveling in the opposite direction, strikes the cable of the gate, and is brought to a stop within 3½ feet because of the additional snubbing action of a heavy weight sliding on rails, and furnishing added resistance.



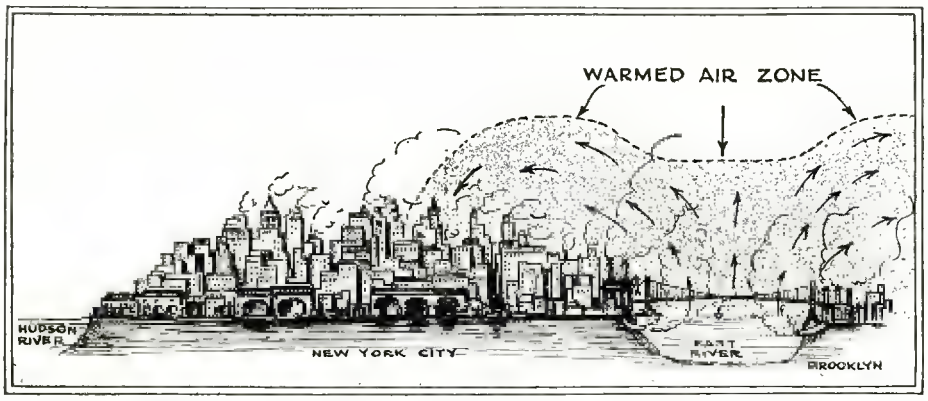
A car traveling at a moderate speed and striking the gate stretches the cable as indicated. Snubbing action not yet effective.

Power Plants Heat River Which May Warm City

IT is not generally known that New York City has its own steam-heated river, but such is a fact. Along the East River there are nine electric light and power plants. In order to condense the steam, these power plants require about 400 tons of cooling water for every ton of coal burned under the boilers. This cool water is required to do its duty, namely that of condensing steam, after the steam has done its work in the great turbines. These power plants consume something like a thousand tons of coal an hour.

The water in passing through the condensers, is raised in temperature about 25° for every five minutes that it remains in the plant, and it is obvious that this hot water must have an effect on the stream, even though that stream joins with the ocean. Actual measurements have indicated that the temperature of the whole river is raised. The East River, by the way is not really a river, but a strait. It has been stated that this increase in temperature of the river is bound to have its effect on the air about the city and raise the temperature of that air. There is no

(*Cont. on page* 170)



This illustration graphically portrays the steam-heated river and the effect which it has on the air passing over it. The nine electric light and power plants along the river edge pour enough hot water back into the river to raise its temperature 10° higher than that of surrounding waters.

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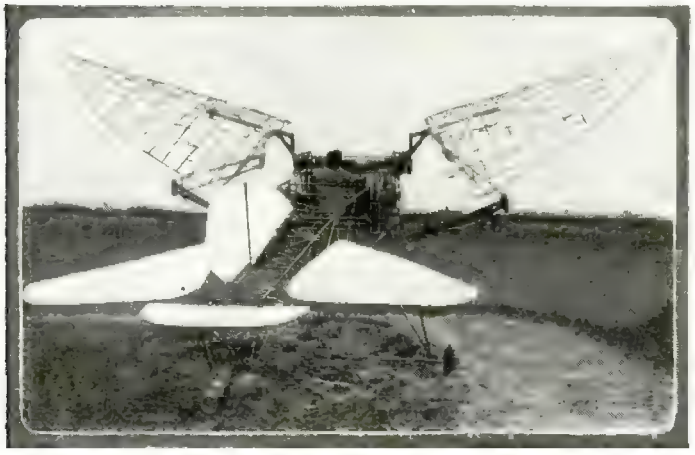
Photographic Picturizations

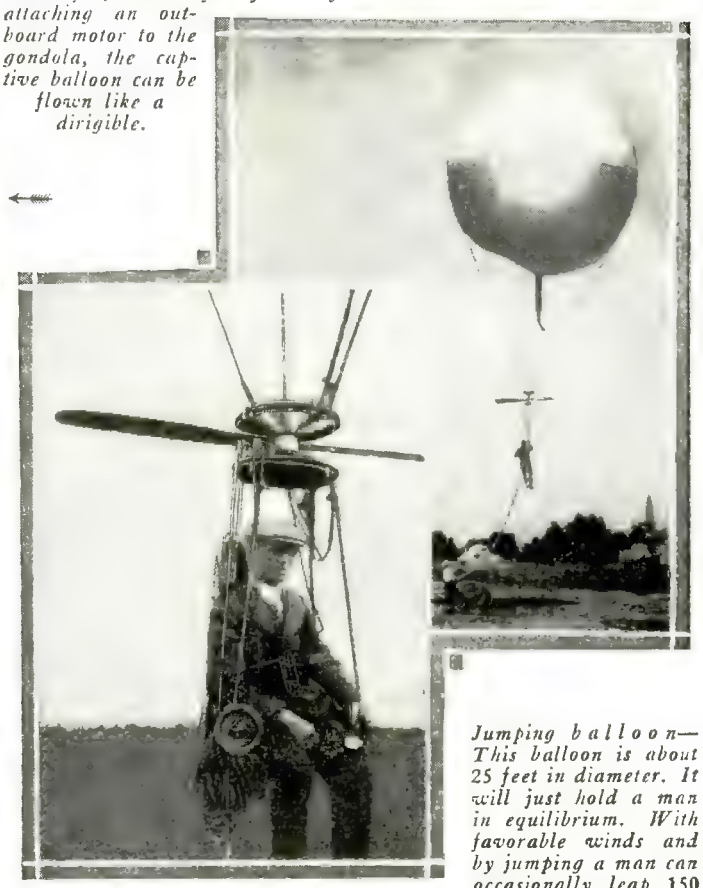
ADVANCES IN

New Developments for Fields, Flight

Novel captive balloon—The photograph at the left shows a novel type of captive balloon which recently made a flight over Friedrichshafen, Germany. By adding stabilizers and rudder and also attaching an outboard motor to the gondola, the captive balloon can be flown like a dirigible.



Ornithopter—Robert Myers of Rockford, Ill., has invented an ornithopter, or wing-flapping type of aircraft. The wings have not yet been covered. He claims to have patterned it from his study of heavy birds in flight.



Jumping balloon—This balloon is about 25 feet in diameter. It will just hold a man in equilibrium. With favorable winds and by jumping a man can occasionally leap 150 feet. Less athletic people may use the small propeller instead of jumping. Pulling on the cable rotates the propeller and causes the individual to rise, reversing causes him to descend.

Has the new glider craze bitten you yet? Throughout the country, glider clubs are being formed. Motorless flight is on the road to popularity.

Ground lights—At the left are the new markers invented by Lieut. John S. Donaldson. These are set in the ground. Each line ends with a T to indicate the direction of the existing wind. The lights are operated from a switchboard.

THE ULTIMATE AIRCRAFT

Developments in aviation indicate that the ultimate type of aircraft has not yet been reached. Will it be a plane that lands in the back yard, or will it be one requiring a landing field and capable of heretofore unattainable speeds? Watch aviation's progress.

Largest Monoplane—The photo below shows the spread of one of the largest passenger-carrying planes in the world.

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in Modern Aviation

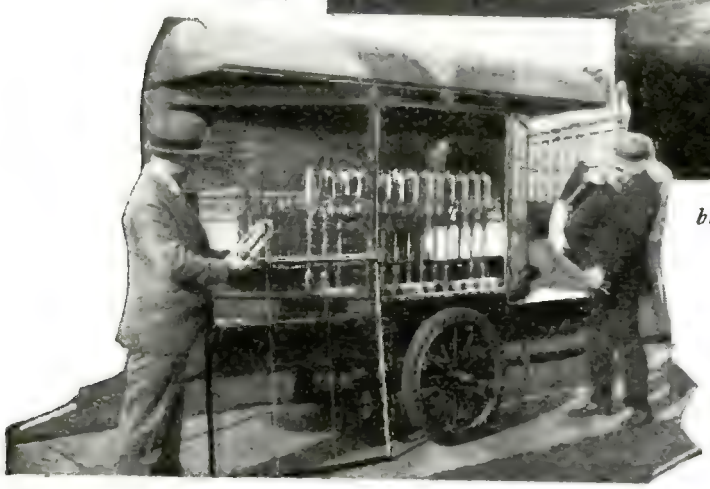
AVIATION

and in Airplane Construction

On these pages we regularly portray the latest progresses made in the aviation industry. The ramifications are numerous; not only do they take in new styles of planes, but also the newer appliances to make aviation still more dependable than it now is.

Above is a rear view of the new style of flood light portably mounted on a truck and provided at either end with suitable braces to hold it securely in place. Diagonally at the left we have a front view of the same flood light with one of the concave reflectors and one of the lamps removed. The lamps are arranged in a row in front of the half-dozen cylindrical mirrors that spread the light over the field without permitting it to rise high enough to interfere with the vision of pilots landing even directly into the beam. At a distance of a mile from these lights a newspaper can be illuminated well enough to be read.

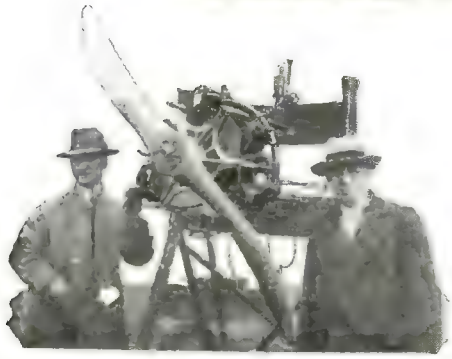
Flood lights—At the right is a photograph taken at night by the illumination of the new type of airport glareless light. Note the even diffusion. →



The shriek of the siren which is wind-driven and attached to a plane turned on the lights in St. Louis streets. The pilot, nearly 2,000 feet overhead, permits the siren ← *to sound.*

Diagonally to the right is the "ear" portion of the combination. This is a sound selective device which, by means of a grid glow tube, and proper selective, amplifying and other apparatus, operates the light switches.

The photo at the right shows George Collins of Lowell, Mass. beside the plane he constructed himself. An automobile engine is used to drive it. Everything else was constructed at home.



The photo above shows a new type of airplane engine invented by Harry A. Palmer, which has no connecting rod, valve tappets, cam shaft, or springs. It weighs 50 per cent. less than any other engine of equal horsepower.

This photograph shows a new addition to the aeronautical field. Both the wings and the tail of this plane can be moved to a slanting position to assist the aviator in taking off, banking or landing.

The unique device here illustrated is for measuring the fuel supply of an airplane to within one-eighth of an inch. A small container connected to the drain cock and to an electrical meter accurately indicates amount of gas. Its inventor is John K. Payne.

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A Picturization of the New

SCIENTIFIC

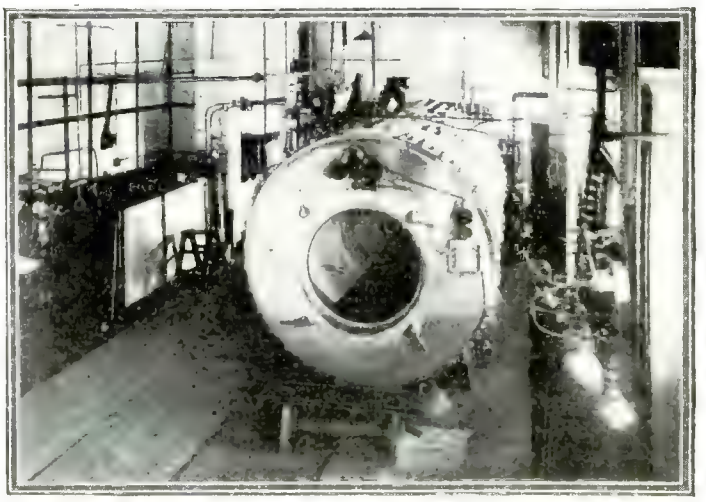
Researches on Land and Sea Add to the Monthly Progress Made by Science

This motor sled is driven by an aerial propeller and is intended for polar exploration. It is capable of a speed in excess of 60 miles an hour.

Aluminum desk guards are now made to protect silk hosiery. Note the guards attached to the desk and chair.

This photograph shows a new boat invented by Dr. F. W. Goebel, the noted German engineer, for use in polar expeditions. It shows how it will act when encountering an ice pack. It is steel armored.

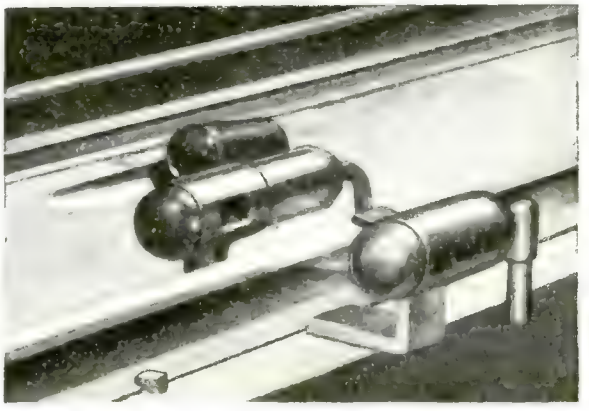
Right—Photo shows C. Francis Jenkins with his latest device for sending movies over the radio. This apparatus was successfully demonstrated.



This photograph shows a large chamber for use in preventing caisson sickness. The diver with the bends is placed within the tank, pressure is applied and then gradually reduced.

Below—The wishbone-like devices are being lowered into the water and are to be towed by a ship. With their aid, oncoming vessels can be detected and the position of the vessel can be determined.

Below—The radio visor for signal and train control. On one side of the track there is a beam of light; on the other side, a photo-electric cell. The passing train wheel cuts off the light beam, and operates the signal.



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Things in Science

PROGRESS

Snapshots Taken in Different Parts of the Country Show Much of Interest

Photographs above show a surgical operation on a chimney. The chimney leaned as is indicated in the photo at the right. After being girdled with straps, some of the bricks were removed, and jacks inserted. These were lowered a thousandth of an inch at a time, and the chimney straightened.

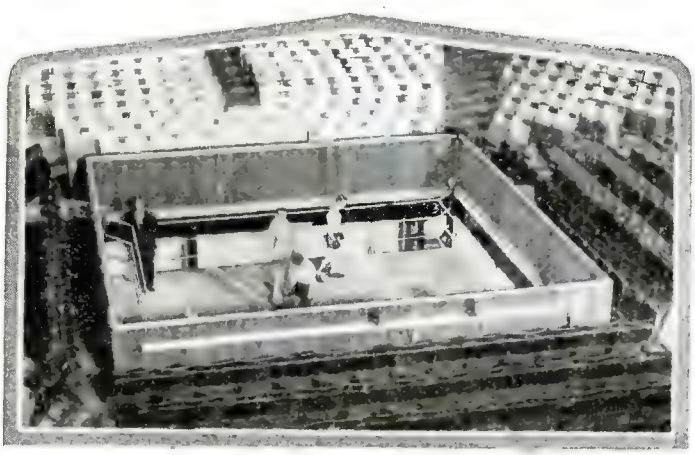
Talking pictures in color and in three dimensions can be seen in this slot machine. This is the first of a number of these machines to be produced. It is planned to give a five-minute show for a nickel.

How one will look at the new perspective color talking movies for five minutes at a time after dropping a nickel in the slot.

The captions tell the story in but a few words. The pictures give the details.

This photograph indicates a new system easily duplicated by the average automobile owner. It is merely a rubber hose with two connections thereon. By its means, air in the spare tire can be used to inflate the other tires of the machine, and pressure can be equalized in all tires.

The photo above shows a new plate for printing. Fabricated by special process from a paper base, it can be directly used for printing because it withstands wear and tear to even a greater extent than metal plates.



Chicago has a disappearing prize ring. This shows it when ready to be occupied by the boxers. When an exhibition is in progress, it rises above the level of the enclosure.

Wartime emplacements with a concrete wall and sand bags are built around the world's largest X-ray tube at the California Institute of Technology in Pasadena, California, to protect the scientists from rays emanating from the 15-foot tube operated by current at a pressure of one million volts.

Right—An instrument used to test the ripeness of fruit such as peaches.

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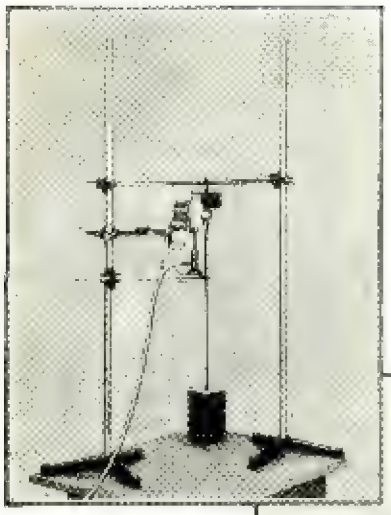
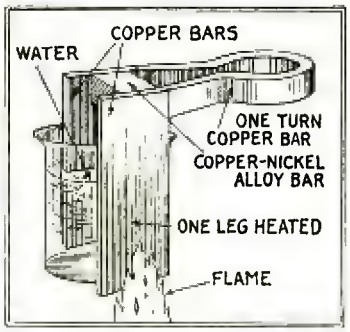
Heated Junction Generates Electric Current In Newly Designed Magnet

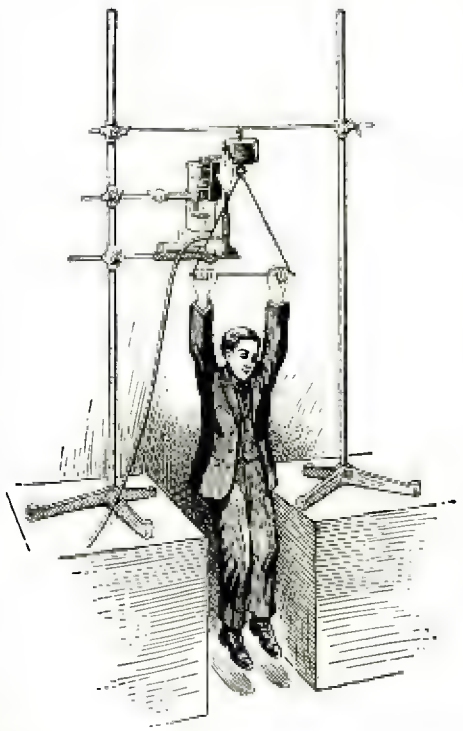
A Thermo-Electric Magnet



The photograph above shows the apparatus as used in a demonstration. At the right is an exploded view, showing the single turn copper bar and the plates.

Pull of Small Magnet Will Sustain a Load of Four Hundred Pounds. Astonishing Results Obtained with Large Current and Small Voltage.



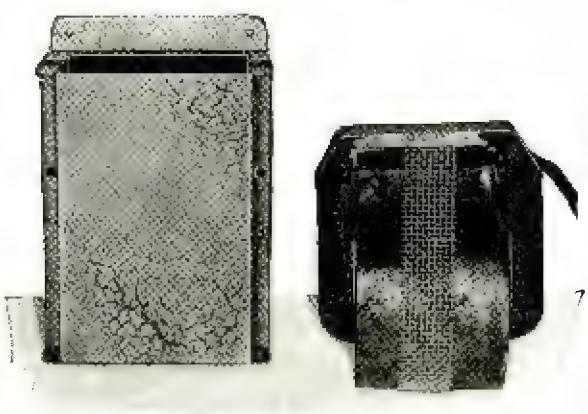


The thermo-couple electro-magnet is strong enough to sustain the weight of a man without detaching the armature.

The drawing at the left shows the construction of the thermo-couple. One of the copper plates is immersed in a beaker of water and a flame plays upon the other.

A THERMO-ELECTRO magnet of astonishing power has recently been developed by Paul E. Klopsteg, of the Central Scientific Co. In the form which proved successful, the electric circuit consists of a single turn of square copper bar. The ends extend outward and between them a copper-nickel alloy bar is silver-soldered. Thick copper plates are silver-soldered to the outer ends of the copper bar. The arrangement is readily seen in the photograph and drawing. The copper plates serve as heat transfer means which have large thermal conductivity and form a thermo contact, through which heat can be delivered or withdrawn from the junctions of the thermo-couple. Both magnet and armature are of soft iron and are in close contact over the entire surface area. In use one of the copper plates is heated and the other cooled in water. With the one-turn coil, it was found that a current of 135 amperes at a potential of .014 volt sustained a load in excess of 400 lbs.

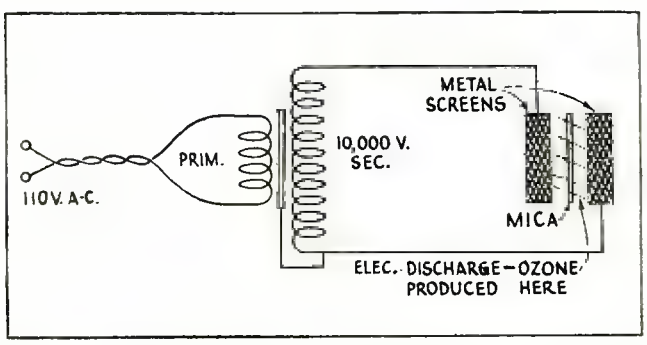
Ozone in the Home



The above photograph shows the home ozone generator with case removed. One of the metal screens and mica sheet are visible.

SEA breeze air can now be had in the home by merely pushing a button. A new device recently placed on the market, releases ozone into the air, destroying the foul odors or revitalizing the lifeless atmosphere.

The apparatus is housed in a metal case provided with mounting plates for attaching to the wall at a suitable height. A transformer with a 10,000 volt secondary is used for generating the electrical discharge which produces the ozone. The secondary leads are connected to two metal screens between which the discharge takes place. The screens are separated by a mica sheet which prevents losses through corona discharges. One end of the secondary is grounded to the transformer core, eliminating any danger of shock, should one come in contact with the device while in operation. The construction is clearly evident from the drawing and photo.



Above is the circuit diagram of the device. The secondary voltage is in the nature of 10,000 volts and the discharge between two metal screens produces the ozone.

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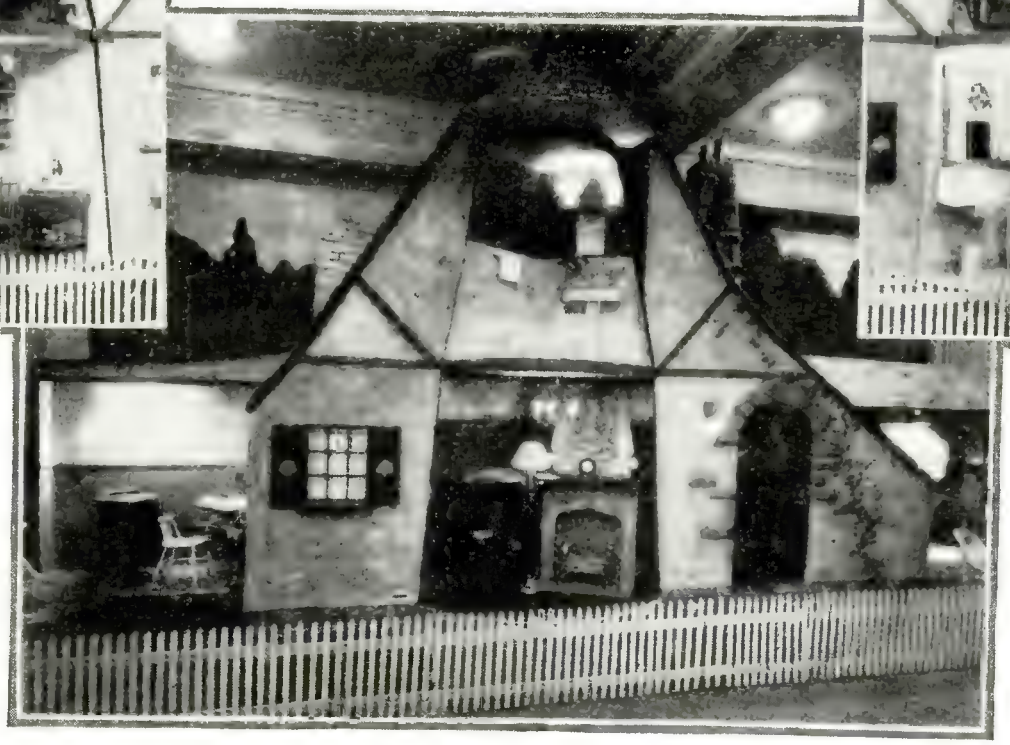
Rotating Electric House Display

ONE of the outstanding attractions at the New York Electrical Show was a rotating house which weighed 3,500 lbs. and was turned by a one-quarter horsepower motor. This two-story structure had the rooms cut away so as to show the interior, which was equipped with all the latest electrical devices now available for home use.

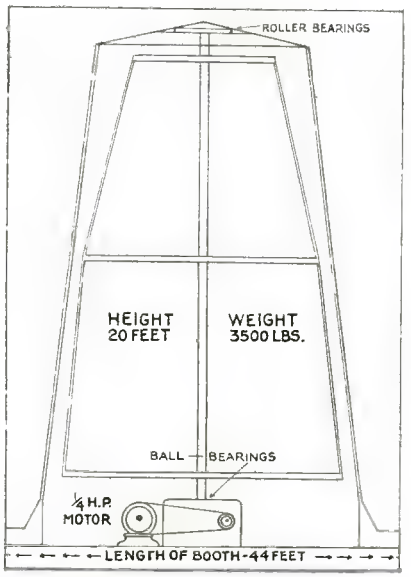
The above photograph shows a sewing room on the upper floor with an electric sewing machine and a dining room on the lower floor having all modern electric appliances, such as, an electric percolator, toaster, waffle iron, chafing dish and grill.



Above is another view showing the laundry at the left equipped with a washer and an electric ironer. In the center is the living room with a socket power radio receiver, electric clock on the mantlepiece with electric torches on either side. The bathroom has an electric heater built in the wall and a therapeutic lamp.

Above, in the upper portion of the house is a bedroom tastefully decorated in the modern manner with an electric bedlight, and a pair of boudoir lamps on either side of the vanity table. Below this is the kitchen with electric dish washer, refrigerator and ventilator.

ALMOST unusual and attractive electric display in the nature of an electric house was exhibited recently at the New York Electric Show, by the New York and Queens Electric Light and Power Co. The house was two stories high and weighed 3,500 lbs. This fitted into a booth 44 ft. long and was slowly rotated by a one-quarter horsepower motor. A shaft extended through the center of the building. Two commutator rings with sliding contacts enabled power to be supplied while the house was turned. The rooms were cut away to enable a view of the interior, in order to show the various electrical appliances which make up a modern and efficient household. Construction was done with wood and wall board coated over with a cement plaster which simulated stucco. On the outside an electric door light of popular lantern design was placed at the entrance. The living room contained an electric floor light, two electric torches, an electric clock and a radio receiver. An artificial fire lit up the fireplace and seemed most realistic in its appearance. Also on the first floor was the dining room having electric toaster, percolator, waffle iron and grill. The kitchen was equipped with an electric dish washer, refrigerator and ventilator fan, all driven by motors. The laundry had an electric clothes washer and ironer. The bathroom on the upper floor contained a therapeutic light and a specially built-in electric heater.



The above diagram shows how the house was rotated by a small electric motor. Roller and ball bearings were used to reduce friction. The shaft extended through the center of the house.

The bedroom on the second floor contained a bed light and two small lamps. The sewing room, also on this floor, was equipped with an electric sewing machine. Most of these various appliances are apparent in the photographs appearing here.

It is surprising what electricity has done for us in the past few years. Household drudgeries have been reduced to a minimum and even the much disliked tasks of washing and ironing are now quickly accomplished with ease. Dishes now can also be cleansed in electric washers built as an integral part of the sink. Even the morning breakfast is prepared by man's faithful servant through the medium of the electric toaster, percolator and waffle iron.

If the heating plant should fail so that the bathroom is rather cold on a chilly morning, it can be brought quickly to a comfortable temperature by simply switching on the electric heating unit which is built into the wall and covered with a grill.

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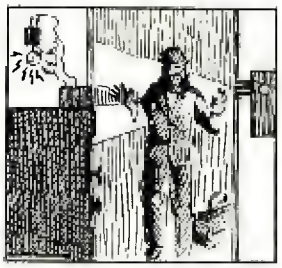
The above illustration shows how one man could turn on the lights in a building with a beam from a flashlight.

The photo-electric cell could also be used in railway trains for automatically turning on lights when entering tunnel.



A burglar alarm system is illustrated above. The burglar intercepts an invisible beam, thus operating an alarm.

A light sensitive cell can be installed on an automobile and when the sun goes down, it automatically turns on the lights.

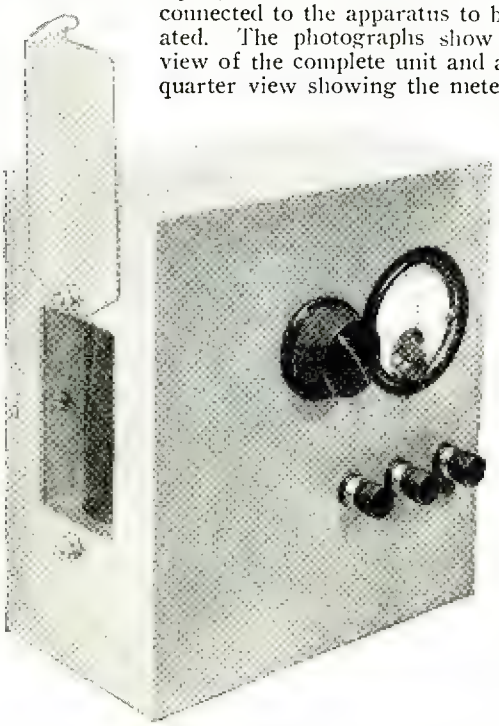
A galvanometer used with the cell will indicate the amount of light and can be used for an exposure meter.

Light Sensitive Liquid Cell Has Many Applications

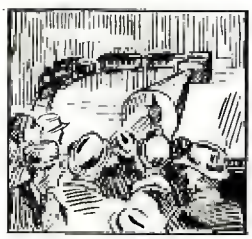
A NEW photo-voltaic cell sensitive to light and filled with a liquid has many applications both commercial and experimental. So sensitive is it, that it will operate a low resistance relay without any amplification whatsoever. Light from a flashlight will generate sufficient current to cause a deflection of 1 milliampere on a galvanometer. Diffused sunlight or lamplight will generate enough electricity to operate burglar and fire alarms, fire and smoke detectors, and the like. Practical applications are unlimited and every manual job that depends on the rising and setting of the sun can be performed automatically.

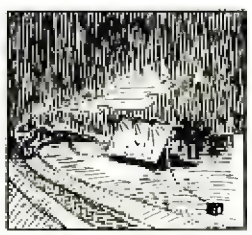
Circuit Connections

THE diagram reproduced here shows a circuit which can be used by the experimenter in his operations. In the new cell a source of potential is obtained by exposing to light one of the two plates immersed in the liquid electrolyte. The voltage appearing across the terminals can then be used to operate a sensitive relay, known as a meter-relay and marked A on the diagram. This in turn actuates another relay B, the terminals of the latter being connected to the apparatus to be operated. The photographs show a rear view of the complete unit and a three-quarter view showing the meter-relay, potentiometer control and window through which the light is allowed to enter and strike the cell. The meter-relay is made from a galvanometer having a 1 milliampere full scale deflection which makes contact at about the .6 milliampere point on the scale. It will be noted that in the presence of light, the resistor R1 is shorted which causes a current to flow through the secondary relay circuit B and operate any device which may be connected across contacts D and E. When in darkness, the relay terminals C and D are closed. The secondary relay B should be capable of actuating on 3 to 6 milliamperes of current and should have a resistance of about 700 ohms. The resistors R1 and R2 are non-inductive capable of carrying 10 (*Continued on page* 188)

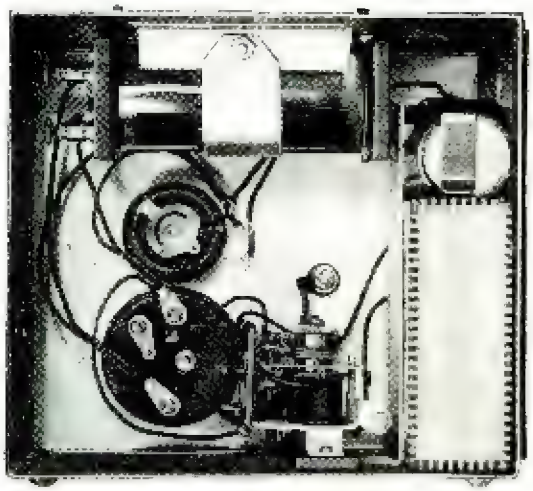


The above photo shows cell and apparatus in metal case. Note window for admitting light.

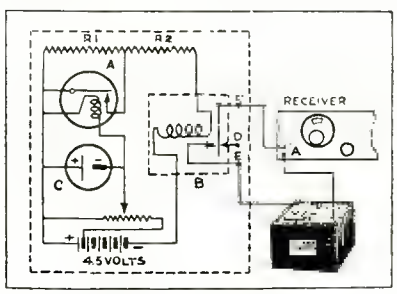




Four more uses for the cell are shown above. These are namely; as a window display for starting and stopping toy railways, for opening the garage door with a beam of light, lighting buoys after dark and illuminating signboard when train passes.



Above is a photograph of a commercial unit containing a light sensitive cell, meter-relay, batteries and relay.



The diagram shown above can be used in performing experiments described.

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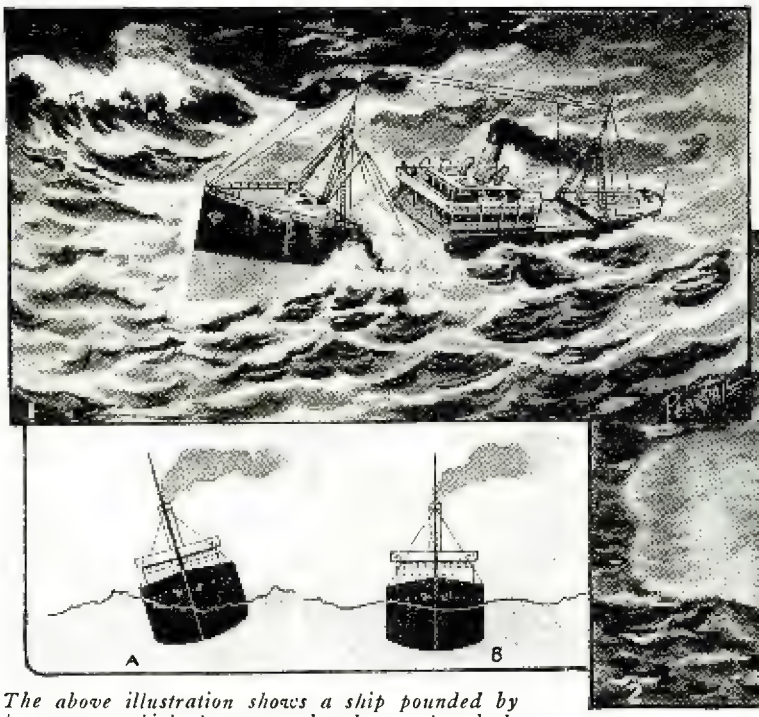
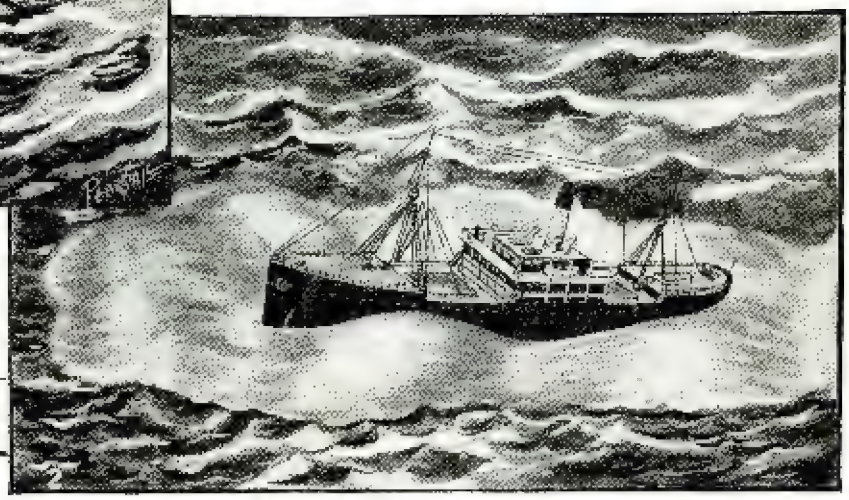
"Pouring Oil on Troubled Waters" Has Long Been Practised by Mariners as a Means for Stilling Stormy Seas. Lake Freighters and Liners Now Find Use for "Storm Oil"



The above illustration shows a ship pounded by heavy seas which threaten to break over her deck. A illustrates how the ship tosses in a stormy sea, and B, the effect of using oil, which eliminates the breaking waves.



A layer of oil surrounding the ship keeps the water still so that it is not ruffled by the winds.

Oil Calms Angry Seas

IN the old days, sea captains carried oil buckets or bags made of canvas punctured with holes and filled with oil which slowly distributed itself upon the waves when a storm arose. The use of "storm oil" has been practised since the days of the clipper ship, but the idea is not often described nor is its worth recognized by the land-lubber. Recently, the S.S. *Northern Star* was caught in a terrific storm which lashed the waters of Lake Erie and high seas poured over her decks and down through any opening hatchway and the like. The captain opened the oil tanks and this liquid flowed toward the stern, covering the surrounding water with a layer of oil which prevented the seas from breaking the winds, and the ship rolling on smooth swells was saved.

Freighters and passenger liners on the Great Lakes are now being equipped with oil tanks. The value of this means of salvation has long been known and countless tales told of how a ship was saved by use of the viscous fluid. The tanks are placed on board the vessel well up in the bow, in order to give the greatest possible protection in a storm. A steam pipe from the engine room maintains a temperature high enough so that the oil will flow out freely, even in the coldest weather. The discharge pipe from the tank is so placed that the oil will have to flow from the bow to the stern of the vessel, and as a result the ship is spared from breaking seas in all directions. But the swells without crests continue to act.

The rolling of the ship is one of the greatest discomforts of ocean travel and many efforts have been made to overcome this trouble. Modern engineering has produced the gyro-stabilizer, which can be installed on vessels ranging in size from a 60-foot yacht to a 10,000-ton airplane carrier.

The small spinning tops which really are small gyroscopes are familiar to all. The gyro-stabilizer operates on the same principle and comprises a heavy steel rotor or fly-wheel driven by a motor. As a wave passes beneath the ship and attempts to roll it in the opposite direction, the gyroscope counteracts the tendency of the vessel to roll. The effect of each wave is neutralized as it reaches the ship. A spinning rotor when suspended will maintain a fixed position and resist strongly any external force which tends to change the position of its axis.

INTRODUCING

Our New Marine Editor,

WILLIAM F. CROSBY

MR. CROSBY, the editor of "Rudder," the oldest marine publication in America, will contribute articles to this journal in the very near future. These will deal with the design and operation of motor and outboard motor-boats. He has written several motor-boat hand-books and many articles dealing with various types of vessels. Since 1909, Mr. Crosby has been engaged in various branches of naval architecture, including the design and testing of ships. He was one of the co-designers of the 110-foot submarine chaser, and has had experience in testing these famous greyhounds of the sea. He has just returned from the yacht races at Miami, Florida, and regularly attends and reports the regattas throughout the country. Our readers undoubtedly remember articles by Mr. Crosby printed in past issues of this magazine which dealt with the design of several types of water crafts. We are sure that many will be interested in the forthcoming boat articles from the pen of so eminent an authority. These articles will also cover the construction of motor-boats and include hints concerning their operation. The design of outboard motor-boats and methods of applying motors to vessels will also be covered.

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How I Built a Stone Garage

By DR. ERNEST BADE

A Cobblestone Housing for the Car is not Only Enduring but Artistic and Looks Well with the Suburban or Country Home

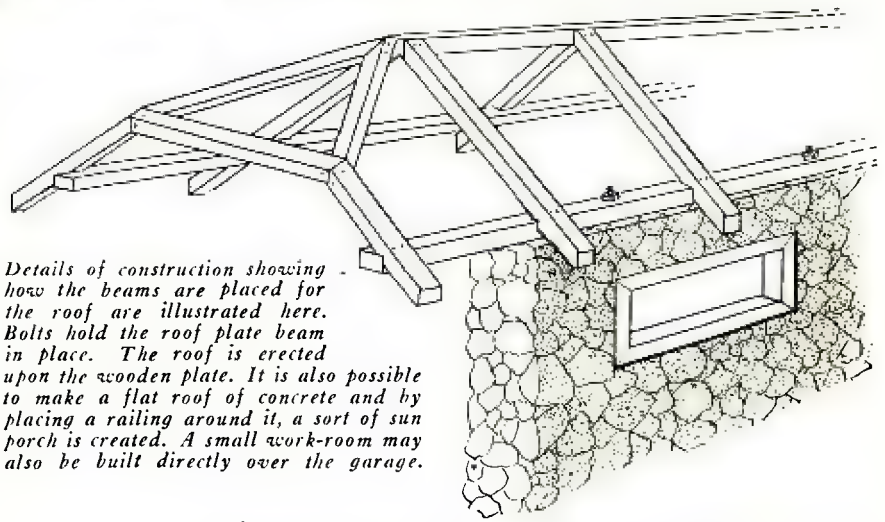
Above is a photograph of the completed garage made in accordance with the information given in the text. A side view appears at the right. An ordinary garage would be out of place where the ground slopes.

THE building of a garage is usually not a particularly difficult undertaking. There are so many different kinds available for instant erection that almost anyone will be satisfied. Of course, at times, certain problems do arise which are only indirectly related to the garage itself. For instance, the slope of the ground may be such that an ordinary garage would be out of place, and then again, the rise of the roadway may be too steep. All of these factors must be considered.

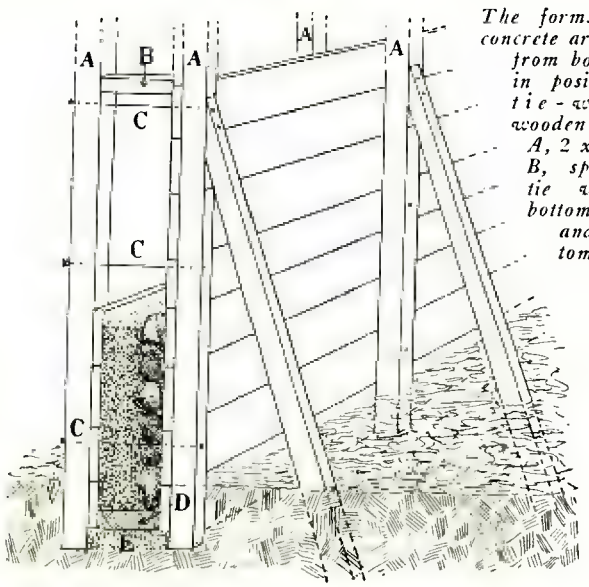
A steep roadway is easy to avoid. Just build the garage into the ground, placing the floor of the garage one or two feet above the highway. Wood cannot be used, nor metal: they would soon be destroyed. Well, then we have brick, cement blocks and rocks left. Which should be used? Brick is not an uncommon material. Cement blocks are also in use. Hewn rock, although not so common, is quite expensive. Cobblestones, that is the answer. Not many garages are built of this material; it is not only enduring, but artistic and fits right into the suburban and country home.

Dig out the space for the garage, or have it dug out, making the floor a foot or two above the roadway. After the space has been dug, smooth off the sides, using a level, and dig out a foundation or footing for the walls. A thickness of eight inches for the walls is usually sufficient. The footing should be about 12 inches if in hard soil and thicker if in soft soil. This footing should extend below the frost line. The outside form is the earth itself, the inside form is built up with beams and boards.

Of course, if the soil is loose and will not keep a level, then boards must be used for both front and inside form. The beams used to hold the board in place should be 2″ by 4″. Build up the form to ground level and pour in concrete, the forms, i.e., the boards, being held in position by both tie wire around the beams and wooden spacers. The studs holding the boards should be spaced from two to three feet.



Details of construction showing how the beams are placed for the roof are illustrated here. Bolts hold the roof plate beam in place. The roof is erected upon the wooden plate. It is also possible to make a flat roof of concrete and by placing a railing around it, a sort of sun porch is created. A small work-room may also be built directly over the garage.



The forms for the concrete are built up from boards held in position with tie-wire and wooden spacers. A, 2 x 4 beams, B, spacers, C, tie wires, D, bottom of form, and E, bottom of foundation.

The concrete should be mixed near the forms so that it can be poured in readily without any extra hard labor. As the concrete is poured in, the wooden spacers are knocked out and removed so that they will not be imbedded. When ground level is reached, rocks and cobblestones of all sizes are placed against the outside form, care being taken that the rocks vary in size. The best results are obtained when no particular effort is made to match the stones either in color or in size. At this point it may be mentioned that the concrete for this last stage should not be too thin nor too thick; its consistency should be such that it flows sluggishly around the rocks. If the cobblestones are dirty and full of clay, they should be washed off with hose or in a large pan with a heavy brush. Cement will not bind on clay, that is why the rocks should be fairly clean. Place the rocks in one layer on the cement. Then pour cement over them and lay the next course. Of course some of the cobblestones will be fairly large while others will be small and soon covered with cement.

If the soil has been used for the front form, then boards will have to be used as the work progresses out of the ground. Here it is best to build up the form as the rocks are being placed so that they may be easily handled.

As soon as the top of the wall is smoothed off, sink a few anchor bolts into the concrete. About four or five will usually be sufficient, for the sides. These are important for the roof beams are to be held down to the concrete by these bolts. If they were absent the roof would sail away some stormy day.

Holes are bored into the roof plate beam to correspond to the bolts sunk into the concrete. Screw the beam down tight on to the concrete and then erect the roof upon this wooden sill. This particular job is not so difficult as it seems. Just use common sense. Of course any particular type of roof desired may be used. In fact, it is perfectly possible to make a flat roof of concrete and, by placing a railing around it, one has a sort of a sun porch. Then, again, a small work room may be built directly over the garage. Usually it will be found best to place a simple roof over it, the garage being built large enough to form a miniature workshop and storage room.

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The Mystery of Matter and Gravitation Explained

Space, Time, and Relativity

By DONALD H. MENZEL, Ph. D.

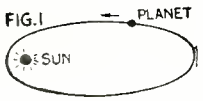

Fig. 1—The elliptical orbit of a planet with ellipticity greatly exaggerated.

RELATIVIST: Gravitation is a mystery. Why does an apple fall to the ground when I let it go?

Physicist: That mystery was explained long ago by Newton. He showed that gravitation is a force that every body in the universe exerts over every other body.

R: Newton showed that an apple will fall *if the force exists.* That does not make its existence any the less mysterious or explain why the force attracts instead of repels.

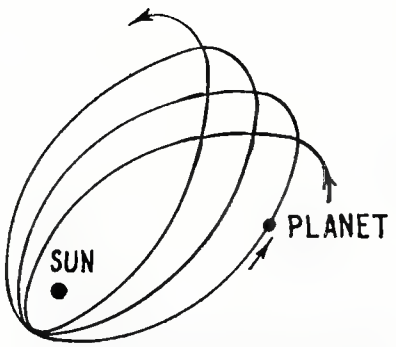

Fig. 2—Above is the orbit of the planet Mercury with the ellipticity and rosette both exaggerated.

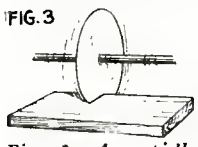

Fig. 3—A rapidly spinning paper disc will cut wood like a circular saw.

P: But we can state the law exactly. The force between two bodies is proportional to their masses and inversely proportional to the square of the distance between them.

R: How do you know it is an exact law of nature?

P: Starting from this law we can make many predictions,—for example, that the orbits of planets should be ellipses with the sun at one focus (Fig. 1) which is, of course, just what we observe.

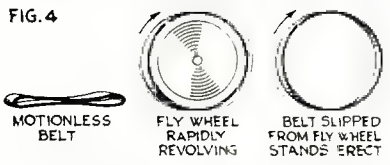

Fig. 4—A belt slipped from a rapidly revolving fly wheel will stand erect.

R: Are your observations perfectly accurate?

P: They are, within a minute fraction of a per cent.

R: Then the most you can say about gravitation is that it is true within that minute fraction.

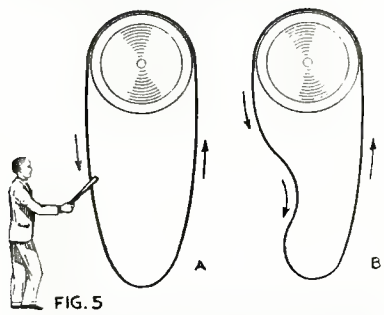

Fig. 5—If a rapidly revolving rope is struck a heavy blow, the rope will continue to turn following the dent which remains stationary. The dent is in the energy and not in the rope.

R: I can suggest a substitute for the law of gravitation that will give you elliptical orbits where you want them, and a rosette for Mercury.

P: That interests me, what is it?

R: Before I go into details, it is important to consider the question of definitions. Certain things are very difficult to define—length and time, for example,—and we must proceed cautiously. (See articles 2 and 3 of this series.) You used the word *mass* in your statement of the law of gravitation. What is mass?

P: Mass is the quantity of matter an object contains.

R: How do you ascertain the *quantity of matter,* say, in that rock?

P: Naturally, that is all we can say for certain but I feel that it must be accurately true.

Mercury's Orbit Disconcerting

R: What about the planet Mercury?

P: I forgot. You have me there. Yes. I admit that Mercury's orbit is a sort of rosette instead of a perfect ellipse (see Fig. 2)—but there may be some disturbing factor that we have not taken account of.

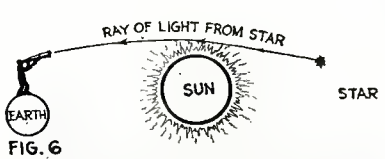

Fig. 6—The above illustration shows how starlight is bent in the sun's "gravitational" field.

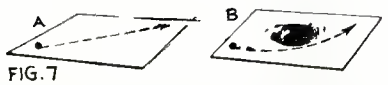

Fig. 7—The square at A represents a piece of tightly stretched rubber. If the rubber is flat a marble will roll "straight." If curved, the path of the marble will be curved but in each case, the path is a "natural one."

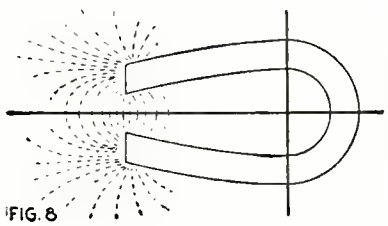

Fig. 8—A horseshoe magnet serves as an example of curved space. We can not see the curvature, but a piece of iron will detect it, for it will not travel in a straight line. If the space were not curved, all the "lines of force" would be parallel to the axis shown.

P: I should weigh it.

R: What determines the weight?

P: The earth's gravitation exerts a force of, say, two pounds on a rock. That is its weight—which also measures the mass or amount of matter it contains.

R Let's see where we are. Gravitation, you said, is a force proportional to the quantity of matter an object contains. Now you propose to measure the quantity of matter in an object by the gravitational force it exerts. That is scarcely logical, is it?

P: I hadn't thought of it that way before. Can you improve on my definition?

R: No. I cannot.

P: Then why do you criticise mine?

R: I shall not criticize your statement as long as you do not insist that it is a definition either of mass or of gravitation. The fact is that you have given me no information as to the "amount of matter any object contains." You may say "this stone contains twice as much matter (weighs twice as much) as that piece of wood," but the absolute thing, mass or matter, is as far away as when you started. You always associate mass with material objects alone. I assert that energy itself has mass.

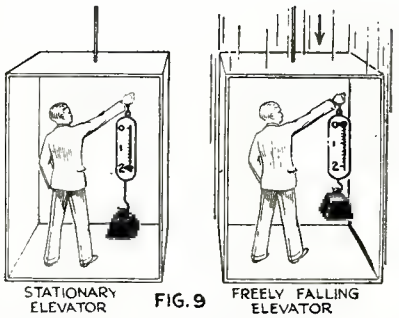

Fig. 9—An object in a stationary elevator weighs 2 lbs. In a freely falling car the object weighs nothing and the force of gravity vanishes.

Moving Ball Has More Mass

P: Do you mean to say that a moving baseball will be more massive than one lying still in my hand?

R: Exactly.

P: If that is a result of the theory of relativity I think I may as well stop right here. I can't

(Continued on page 188)

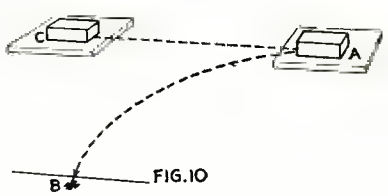

Fig. 10—At one moment box on shelf is at A, a quarter of a second later at C. Its path in the interval being AC. If the shelf were not there, the object would have fallen and struck the floor

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House Plans You Can Read

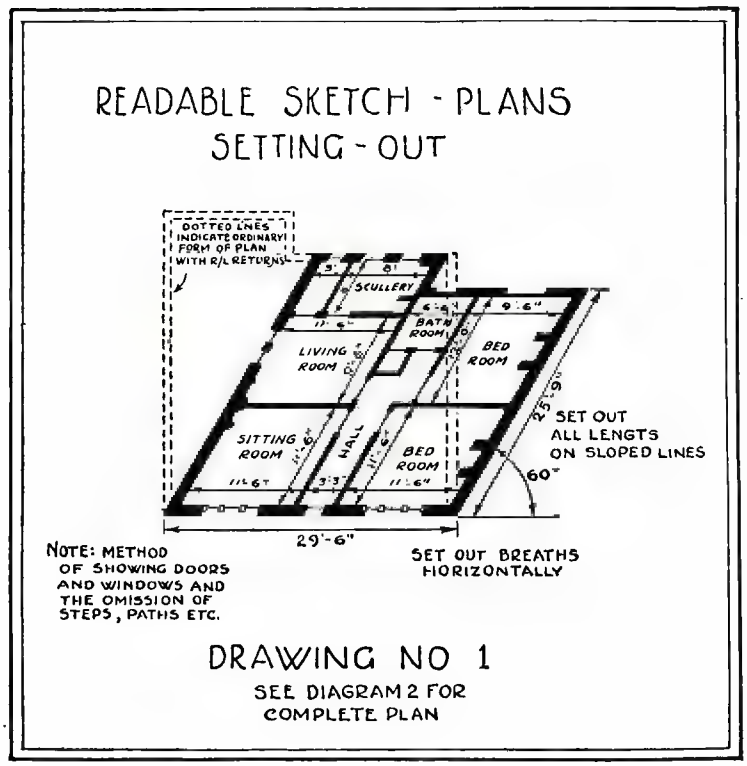
By J. E. LOVETT

ONE of the first and most important duties of the architect is to design the structure exactly as the client requires it, or, if his suggestions are impracticable, to suggest alternative design or arrangement. It is very necessary, therefore, that a definite understanding should exist between designer and client if the work is to be completed to mutual satisfaction.

To attain this end the client should be made fully conversant with the architect's interpretation of his verbal instructions, so that he can compare the building he requires with the one which the architect understands him to require. Where this precaution is overlooked, or ignored altogether, it often leads to bad feeling between the parties concerned, and not infrequently to litigation.

The sketch plan is almost always adopted as common language between the architect and his client, but so very few laymen are able to read even this, the simplest of drawings, that the average client finds great difficulty in visualizing a structure from plans or elevations. Very often, indeed, it is discovered that a client will assume understanding of the details of a proposed structure, presumably to avoid being considered a "thick-head." This seems in itself sufficient evidence to justify the revision of our systems of depicting proposed structures.

The layman cannot understand a plan because it is not represented on paper as it would actually appear in perspective. The ordinary plan is drawn in the second or superficial dimension, that is, simply length by breadth. The actual structure is in the third or cubic dimension, that is, length by breadth by depth. Thus the absence of depths from the ordinary plan makes it almost unintelligible to a person who has not previously had very much to do with architectural drawings.



In the view illustrated above, the ordinary form of plan with right angle returns is indicated in dotted lines. The artist or the prospective home owner lays out the plans with the lengths at an angle of 60°, and all dimensions to scale as in the original plans. This produces an isometric projection. Verticals are then added, and the result obtained in indicated in drawing 2.

These plans here described are nearly as effective as a model, in explaining the proposed homes to the new owners.

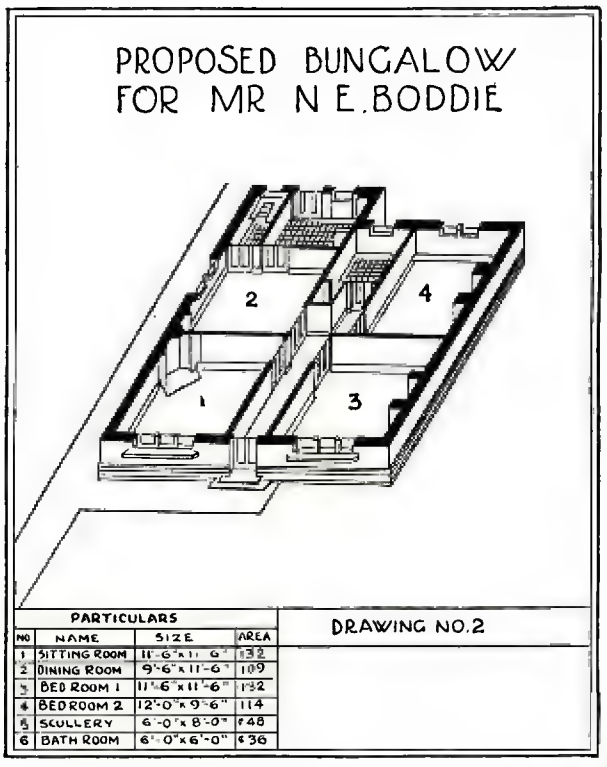
Therefore, it seems necessary that the sketch plans of a proposed structure should be presented in some sort of "perspective," which would enable one to see the rooms sectionally to determine the suitability of the arrangement.

Two important matters have always to be decided between architect and client respecting a proposed building, namely, the question of planning and the question of facade design or treatment. To either or both of these the client offers certain vague or useful information for the designer's guidance, and when he has prepared the sketches they embody his conception of the requirements of the client. It is very necessary afterwards that the client should be enabled to thoroughly understand the sketches, in order that he can assure himself that the architect has understood him correctly.

The presentation of the elevations of a structure is generally sufficient to enable the layman to visualize the appearance, but it is the plan and the arrangement of rooms, etc., which he finds most difficult to understand. In view of this fact, it seems strange that there are two methods of assisting him to visualize the appearance of a proposed building (besides the ordinary elevation), but neither the perspective sketch nor the architectural model can show him the arrangement of the rooms in their relationship one to another, and to the structure as a whole.

Moreover, to the client the appearance is a secondary matter, and of much less importance than economical and satisfactory planning, sufficiency of light, convenience of domestic fitments, and the hundred and one things which make all the difference between a labor-saving and a labor-making house. The

(*Continued on page* 175)


PROPOSED BUNGALOW
FOR MR N E.BODDIE
2
4
1
3
PARTICULARS
DRAWING NO.2
NO | NAME | SIZE | AREA
1 | SITTING ROOM | 11'-6"x11'-6" | 132
2 | DINING ROOM | 9'-6"x11'-6" | 109
3 | BED ROOM 1 | 11'-6"x11'-6" | 132
4 | BEDROOM 2 | 12'-0"x9'-6" | 114
5 | SCULLERY | 6'-0"x8'-0" | 48
6 | BATH ROOM | 6'-0"x6'-0" | 36

The home owner finds it much easier to read a plan of this type than a straight blueprint. He can visualize the internal appearance of his home and make any changes he might desire.

Right: It is very difficult to make some people understand blueprints. ➟

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How You Can Make and Use a Small Air Brush

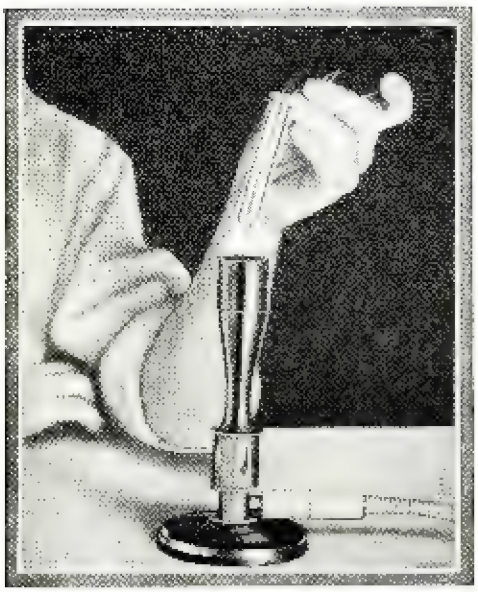


Fig. 1—Hold a one-inch tube in the flame of a Bunsen burner or of a gas stove, until the hole in one end has decreased in diameter until it is no larger than a small pencil.

AIR BRUSH *for* Decorating Small Objects

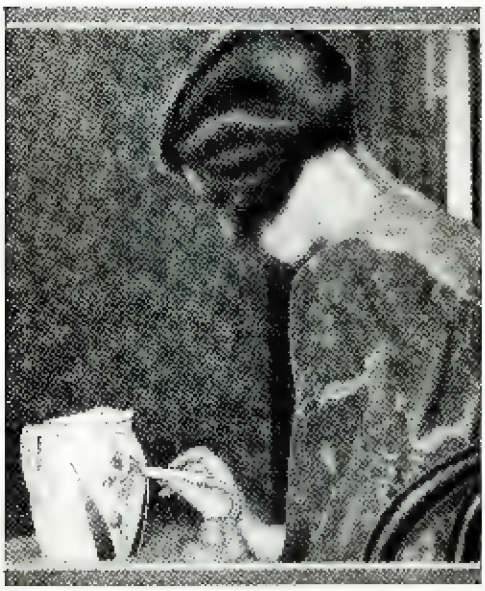


Fig. 6—This illustration shows how the air brush is used for decorating pottery and other small objects at home. Air pressure is supplied by pressing on the atomizer bulb.

By KENNETH B. MURRAY

THE air brush is coming more and more into favor for various kinds of painting. Leaving no brush marks and producing shaded work in any degree of softness, it is deservedly popular for painting automobiles, furniture, etc.

A miniature air brush that can be used with the larger models now on the market for brushing in small decorations and details, or alone in producing exquisite free-hand or stencil decorating on chinaware, dolls, and various Christmas gifts, can be manufactured in the kitchen from easily obtained materials, at small cost, in an hour.

Glass is the easiest material to work with, as it can be drawn out to any fineness in a hot flame.

The air brush illustrated, capable of doing an excellent grade of painting, lettering and shading on home objects, was made from glass tubing. A one-inch tube five inches long was first held in the flame of a Bunsen burner (as an alternative, the hot flame of a gas stove) until the hole in one end had decreased in diameter and was of no larger opening than a small pencil (Fig. 1).

Next, a length of smaller tubing was heated and drawn out into a narrow tube with a half bulb on one end (Fig. 2). Another piece of the same glass was drawn at one end to a point with a hole as large as the lead of a pencil and there broken off.

Fig. 2—This shows the second stage in the making of the air brush. A small tube is heated and drawn out and the opposite end is enlarged. The details of this can be seen in Fig. 3.

The narrower tube was heated on the narrow end and bent to a right angle and then broken off. The hole was so small that the very point of a fine needle just fitted it. The other end has a large bulb, into which colors may be dropped when the brush is completed. The tubes are next fastened together with a strip of adhesive and the same relationship or closeness as shown in Fig. 3 must be obtained, so that air passing through the larger tube will strike the curved tip of the small tube in such a way to carry away in a fine spray small quantities of color held in the latter.

A further view of the adjustment of the tubes is shown in Fig. 4. A paper tube has been made, the tubes slipped into it and the space around the tubes filled with plaster of Paris. When it is set the paper can be removed, and the two glass tubes are held firmly in place quite permanently.

Fit the latter into the larger glass first made, so that the tips are centered in the mouth. It may be necessary to wrap a piece of adhesive around the plaster cast to make it fit tightly in the larger glass holder.

(*Continued on page* 181)

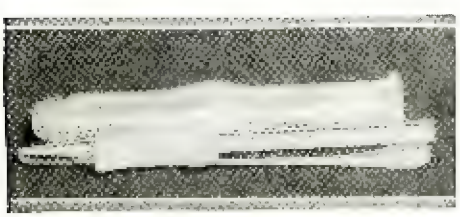
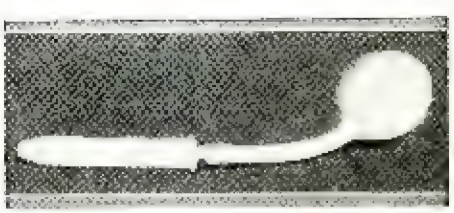


Fig. 3—This illustration shows the two glass tubes bound together with a strip of adhesive tape. Note the relation of the tubes to each other.

Fig. 4—After the tubes have been properly placed and the spray tried, the sprayer is slipped into a paper tube and the space filled with plaster of Paris.



This illustration shows the air brush complete, the tubes having been pushed into their glass holder. It is extremely easy to use this appliance. Fig. 5.

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Making Your Own Cement Walk

By H. L. WEATHERBY and P. P. B. BROOKS

Artificial Stone Footpath Is Easily Made and Provides a Durable and Artistic Walk to the Front or Rear Entrance

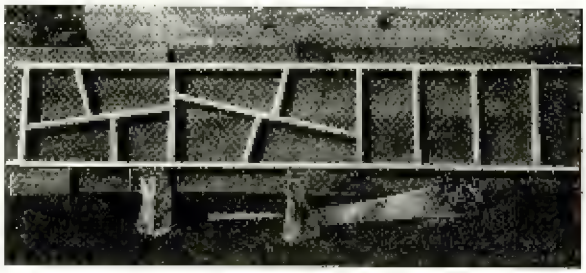
The above illustration shows the completed walk with blocks set in the ground, so that they will not interfere with the lawn mower.

"THIS is the Age of Concrete," remarked Mr. Brown at the supper table. "The states are tied together from shore to shore with great bands of concrete pavement. Concrete bridges span our rivers, concrete skyscrapers house millions of office workers and tenants, huge concrete dams impound the waters of our rivers and force them to generate electric power to be carried to factories and homes over thousands of miles of copper wires suspended from giant concrete posts, while smaller posts support the wire that fences our farms, concrete barns house the farmer's stock, and concrete silos store their feed. There are all kinds of concrete vats, tanks, cisterns, reservoirs for the storage of water, oils, and other products of industry, concrete ships and barges, concrete sidewalks, foundations for all kinds of buildings, concrete floors, concrete roofs,—*concrete without end.*

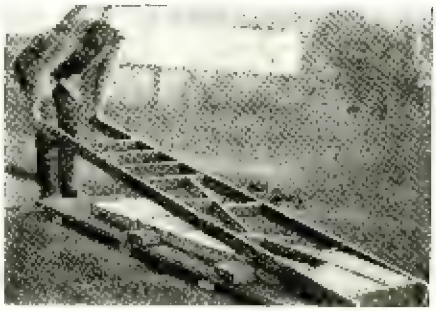
"Concrete is an artificial stone made by cementing together suitable rock particles of varying size after the fashion of Nature. But modern man has gone Nature one better, for while Nature takes millions of years to build vast, shapeless masses of seamed and sometimes nearly worthless sandstone and limestone, often hundreds of miles from where they are needed, modern man builds, almost overnight, exactly where he wants it, in whatever shape he wants it, bridge, silo, factory building, home, or what not, in one seamless piece of massive stone. How did the world get along all these centuries without it?"

"But, daddy, it did not," said little Mary. "I learned in my history, today, that the Roman Emperor Hadrian built the dome of the Pantheon of concrete. The dome is one hundred and forty-two feet across and stands one hundred and forty-two feet high at the center, where there is a hole in the top thirty feet across. And the history says that it stands as perfect today as it did when the workmen knocked out the props that supported the forms 1800 years ago."

"Yes," said Mrs. Brown, "I wonder how much of our concrete of to-day, made in this age of speed and efficiency with its rush, slam-bang methods, will be here 1800 years from now. Knowing nothing of what we call Portland cement, the Romans made a natural cement by crushing and firing stone of suitable composition. The Pantheon dome, with no steel re-inforcing, is, I believe, without a parallel in modern concrete engineering."



Covering the concrete and wetting the cover occasionally results in a stronger product.



The photograph above to the left shows the concrete being mixed. Directly above is the wooden form which rests on a platform of rough lumber. The photograph at the left shows the form being removed. This is easliy done if the wood has been thoroughly greased beforehand.

"Well at any rate," said Mr. Brown, "none of our modern structures have stood 1800 years yet."

What Is Portland Cement?

"WHAT is Portland cement?" asked Willie.

"Portland cement," said Mr. Brown, is made by grinding together in the correct proportions, limestone and clay. The mass is then fired in kilns to a high temperature. The clinker that comes from the kilns is ground to a very fine powder. The firing has changed the chemical character of the mass, forming new compounds and driving off water. When the cement gets wet it combines with a certain proportion of water, forming another new substance which possesses a certain degree of hardness and toughness. When this change occurs we say it '*sets.*' Pure hardened cement, however, is too expensive and not strong enough to be of practical value. So it is used to hold together rock particles very much like glue, when it is used with wood. You (*Continued on page* 171)

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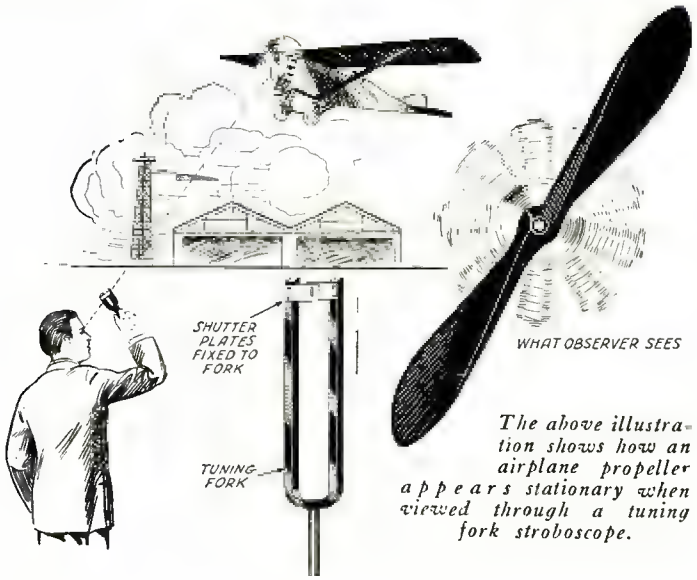
How to Use the Stroboscope

Moving Mechanisms *Appear* Stationary *by* Flicker Light



The above illustration shows how an airplane propeller appears stationary when viewed through a tuning fork stroboscope.

The Stroboscopic Principle Permits the Study of Moving Objects. This Phenomenon and Its Applications are Explained

Simple Stroboscopes for the Experimenter are Described Here. Causes of Trouble often Revealed with These Instruments

By PHILLIP DAWSON

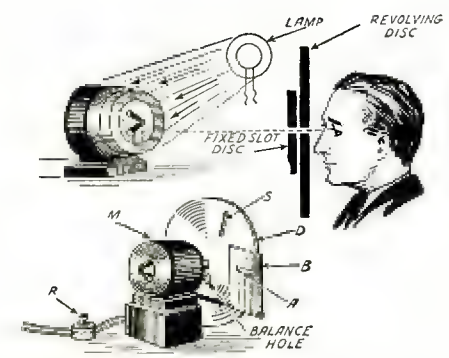
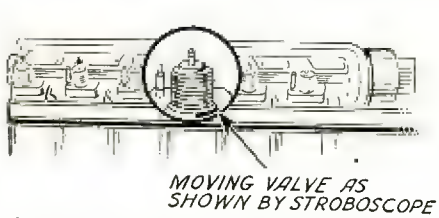


Fig. 1 above, illustrates a method of constructing a stroboscope. The speed of the motor is controlled by a variable resistance, so that it can be synchronized with the speed of the machine under observation.

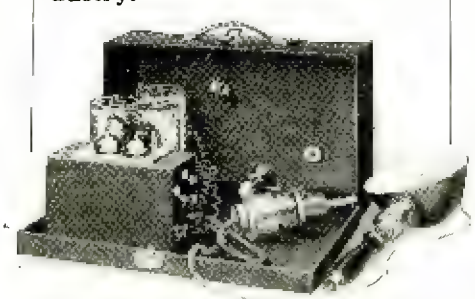
THE motion of the most complicated mechanism can be studied no matter how fast it is traveling by using a device known as a stroboscope. The only requirement necessary for its application is that the motion should be cyclic. The moving parts should perform the same operation for each revolution of the machine. Obviously, it could not be used for studying the flight of a bullet but is of great use in modern industry.

DO you know that it is possible to study minutely the motion of the most complex piece of machinery no matter how fast it is moving?

The rapidly revolving and oscillating parts of the machine can be made to appear perfectly stationary to the eye in successive positions of their operation, revealing to the observer exactly what is happening to the intricate parts when they are called upon to function at speeds far beyond the range of observation with the naked eye. A simple piece of apparatus known as the *Stroboscope* makes this phenomenon possible, and the only requirement necessary for its application is that the motion should be cyclic, that is that the moving parts should perform the same operation for each revolution of the machine.



The valve gear of gasoline engines is a frequent source of trouble and stroboscopes are often used to investigate them. Sometimes, the valve will be seen to bounce two or three times before it comes to rest on its seat. This condition leads to broken springs.



The above photograph shows one of the commercial stroboscopes which employ a neon tube and give remarkable results. The arrangement of an electric flash stroboscope is shown in Fig. 3.

For instance a stroboscope cannot be applied for the study of a bullet hitting a target, whereas it is of great value for watching the action of the valves of automobile engines which open and close a thousand or more times per minute.

The Stroboscopic Principle

THE stroboscopic principle has been known and applied by engineers for fifty years, but it is one of those very useful phenomena which for some reason has been quite neglected, and it is only during the last five years that commercial stroboscopes have appeared on the market as standard pieces of equipment.

The reason for the recent appearance of commercial stroboscopes is the perfection of the Neon lamp with which most modern highly efficient stroboscopes are equipped.

There are several ways of making a stroboscope but they all depend upon the principle of giving the observer a succession of rapid glimpses of the moving machine, the glimpses being so timed that they are in synchronism with the movement. (*Continued on page* 176)

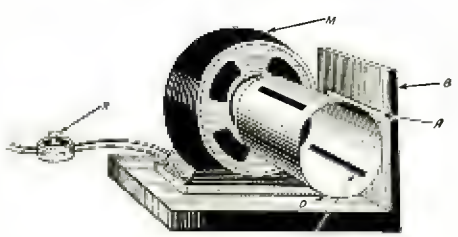


Fig. 2, above, shows how a piece of tube is used instead of the slotted disc. Two axial slots are cut diametrically opposite to one another. A screen B is placed so that its aperture A registers with the slot S and the opposite one once per revolution.

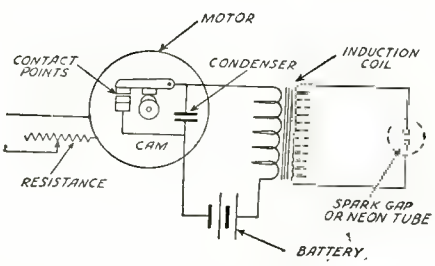


Fig. 3. The schematic circuit of an electrical flash stroboscope is shown above. A resistance controls the motor speed and consequently the period of flash of neon tube or spark gap. This stroboscope is of the direct vision type.

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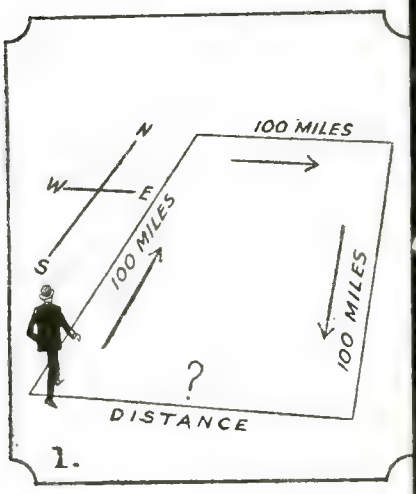
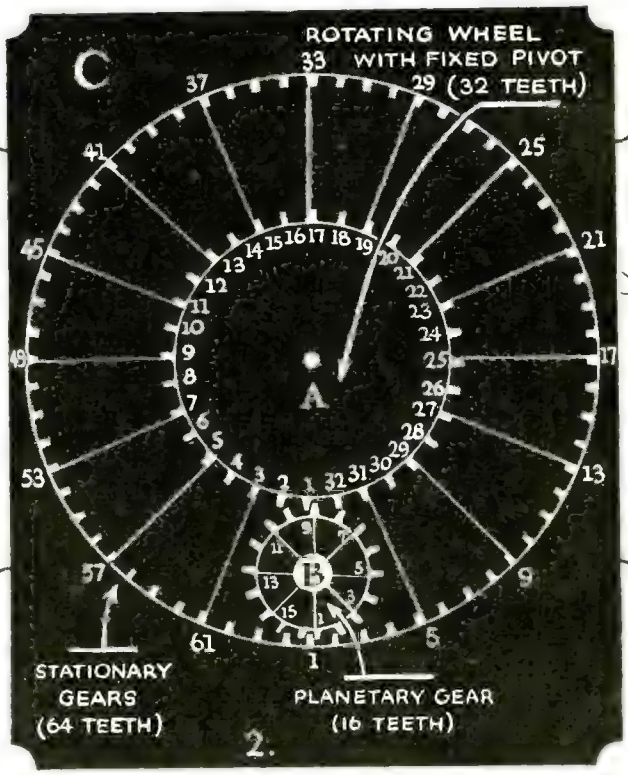
Travel 100 miles north, then go east for 100 miles, and then south for 100 miles. How far will you be from the starting place?



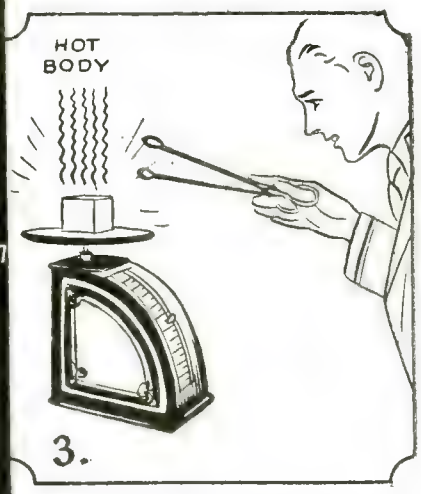
1.



2.

How many times must the central wheel A turn to have the planetary gear B make a complete excursion around A, and return to its starting point? During this time how many times will B rotate on its own axis?

Assuming that no decomposition or evaporation takes place, does the weight of a body change when heated?



3.

Scientific Problems and Puzzles

By ERNEST K. CHAPIN

THE student and amateur scientist will find much instructive entertainment in solving the puzzles presented here. Anyone with a good knowledge of physics will find no difficulty in arriving at the correct solution. Some of the questions will be found rather elementary, while others will require a bit of cogitation before they are finally answered.

If you have any difficulty in solving this month's puzzle page, the answers will be found in the back portion of the magazine. The questions illustrated in the numbered drawings are as follows:

1. If you travel 100 miles north, from where you live, then 100 miles east, and then south for 100 miles, how far will you be from the starting place?

2. How many revolutions must wheel A make to turn gear B around A once? In making one complete excursion how many times will B rotate on its own axis?

3. Does the weight of a substance change upon being heated? It is assumed that no decomposition or evaporation occurs.

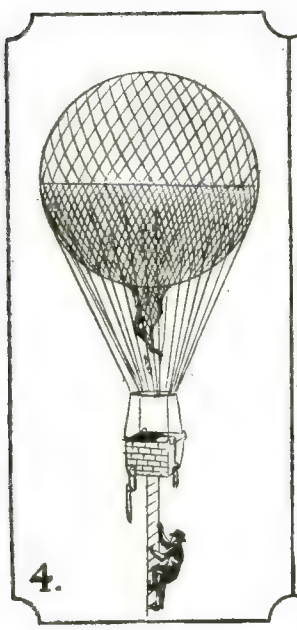
4. A balloon and its load are perfectly balanced and motionless in still air. A man stands on the lower rung of the ladder hanging from the basket. What will happen when he climbs up the ladder? Will the balloon rise or fall?

5. Wheels on railway cars are fastened rigidly to the axle, so that both must turn at the same rate. Yet, in rounding a curve, the outer wheel must move over a longer arc than the inner wheel. How is this possible without slipping?

6. When a wheel rolls along a track without slipping, does each point on the rim of the wheel come to a full stop with respect to the track each time contact is made?

7. Gold can be hammered into sheets one three-hundred-thousandth of an inch thick. If a sphere of gold one foot in radius were hammered into foil what area would it cover? Guess, and then spring this one on your friends.

8. Does a lightning rod decrease the amount of electric discharge in its vicinity? (*Continued on page* 189)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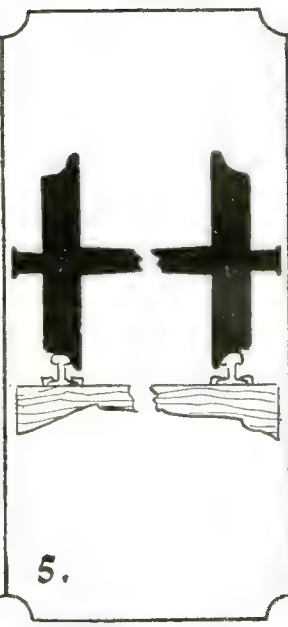
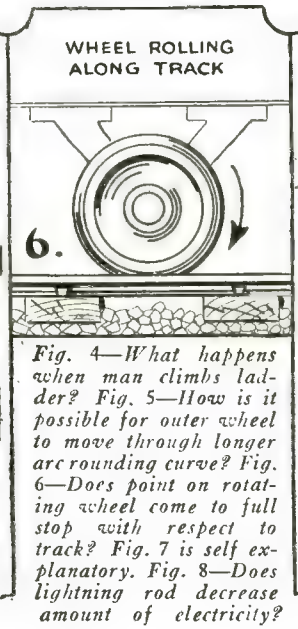

5.



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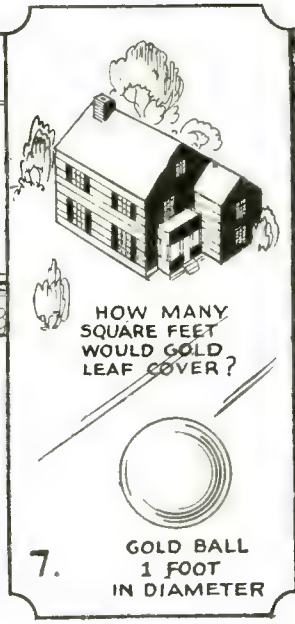

7.

8.

Fig. 4—What happens when man climbs ladder? Fig. 5—How is it possible for outer wheel to move through longer arc rounding curve? Fig. 6—Does point on rotating wheel come to full stop with respect to track? Fig. 7 is self explanatory. Fig. 8—Does lightning rod decrease amount of electricity?

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An oriental mystery: In this effect the wizard displays a brass container about twelve or fourteen inches high which he fills with rice to overflowing and then levels it off. This rice is poured from the jar into a large platter. Making several mesmeric passes over the container, he pours the rice back into it and to the amazement of the onlookers, it has mysteriously multiplied to twice its original amount, judging by the overflow. The secret is simple. The inside of the jar has a hollow semi-spherical compartment mounted on pivots which can be turned from the outside. When rice was originally poured into the vessel, the mouth of the sphere was turned upwardly. When it is required to multiply the rice, the compartment assumes the position indicated in the drawing at the extreme right.

INTERESTING TRICKS FOR ANY ENTERTAINER

Tricks for Amateur, Parlor, Lyceum and Professional Entertainer

Magic

By DUNNINGER

NUMBER SEVENTY OF A SERIES

The Mystic Star

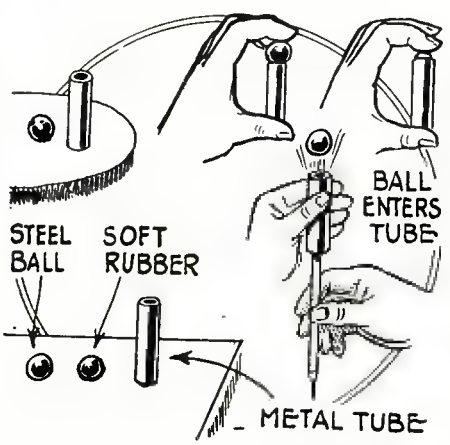
THIS is an entirely new trick which can be presented as an impromptu mystery. The apparatus consists of a five-pointed star painted on a red card. After relating some plausible tale describ-

A star painted with luminous paint permits one to produce an extremely interesting mind-reading effect, which can be repeated as often as desired.

ing the mysterious powers of the star, he requests a spectator to place some object on the star and gaze at it while the magician leaves the room. The spectator is then told to pick up the object, secrete it in his pocket and the magician is to tell him what it was. Picking up the star, and going into a further corner of the room, the magician requests concentration and then announces to the audience the article thought of by the spectator. Secret: the star is painted with luminous paint and shows by shadow what the object was. Walking to a dark corner enables the performer to see the shadow.

Ball and Tube Mystery

AN ordinary brass tube, about one-half inch in diameter and an inch and one-half long, is passed for examination, together with a steel ball, too large to fit into the tube. The wizard holds the tube and ball between his fingers, as illustrated, and visibly pushes the ball into the tube. With a pencil he forces the ball out again, and then passes both objects for examination so that any member in his audience can try the effect. Like most magical mysteries, the secret is simple. Two balls are used. The steel ball

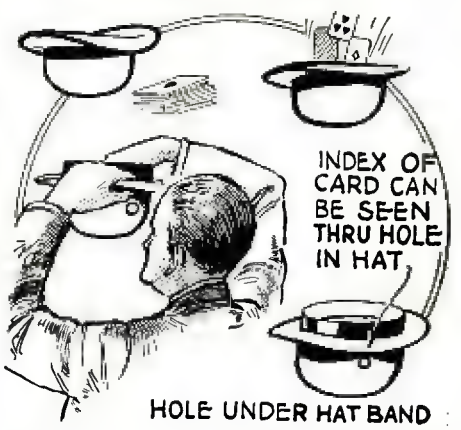


A steel ball can apparently be made to enter a tube, much too small for it, if it has previously been exchanged for a rubber ball.

can be painted black, or the rubber one can be silvered. The rubber ball is secretly palmed while the steel ball and tube are passed for examination, and the exchange is made at the moment the steel ball is returned by some member in the audience.

Reading Card in Hat

THIS trick can be repeated as often as desired. The magician asks someone to pick out three or more cards out of a deck at random, and drop these cards into a derby. Lifting the leather sweat-band



Because of a hole cut in the side of a hat, a magician is enabled to name any cards dropped into the hat. Except when demonstrating, ribbon and band cover the hole.

to prevent a view of the contents of the hat, the magician raises the hat above the level of his eyes and then, as if looking through it, he names the cards and in turn produces them one by one in the order named. The secret lies in the fact that a small hole has been cut in the hat, so that it will be covered by the sweat-band on the inside, and the ribbon on the outside. The ribbon is pushed away by the thumb, while demonstrating the effect, and the magician actually looks through the hole in the hat and names the cards as he reads the indexes.

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At the left is a photograph of a bat which was taken while the bird was in actual flight.

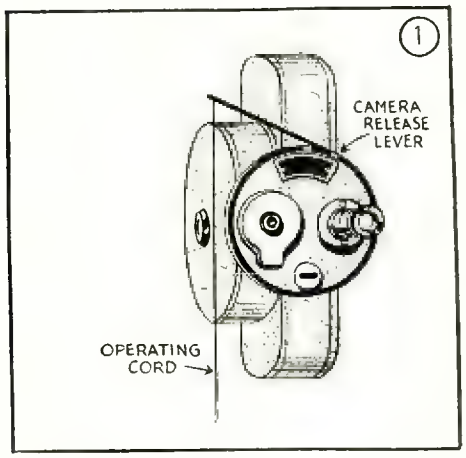
Fish, Animals and Birds Pictured in Natural Settings Make an Interesting and Educational Film for the Amateur Movie Enthusiast

HOME MOVIES

Conducted By DON BENNETT

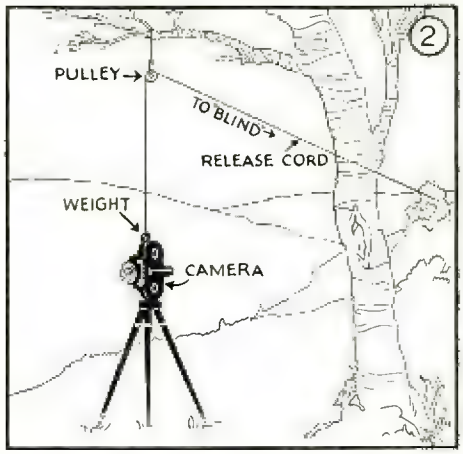
Hunting With Camera and Film

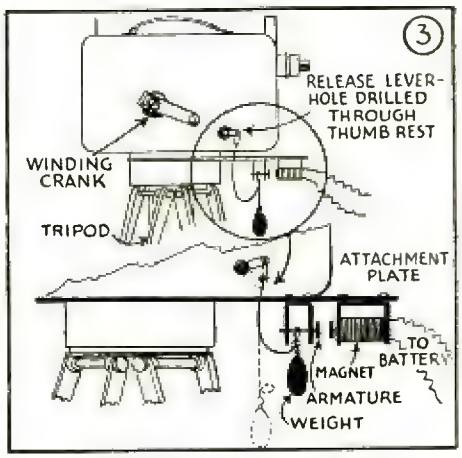
New Fields for Camera Owner Offered in Wild Life Movies



The above illustration shows a mechanical release designed for "stop-motion" work.

For continuous operation a weight can be used and released from a distance. This will press down the button until the spring unwinds. The arrangement is shown below.





For continuous operation a weight can also be released magnetically, as illustrated above.

IT is June and in the country all the wild life is astir. In most cases the hunting season is closed, that is, for the man who does his hunting with gun or rod. But for one hunter there are no closed seasons—the camera hunter. He steals forth with camera loaded, case full of telephoto lenses, filters ready—and perhaps a trap arrangement for making the game take their own pictures.

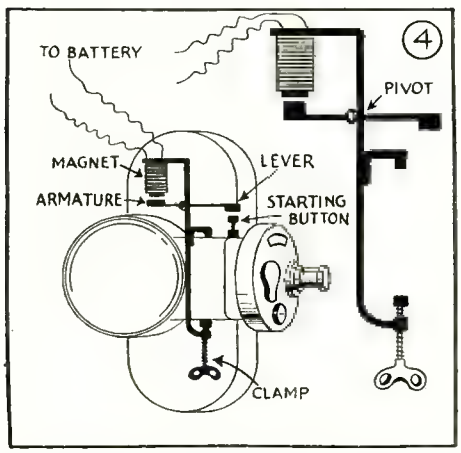
The sunny days of June had inclined the thoughts of the members of the Rockland Movie Club toward hunting expeditions with their cameras, and the meeting was to be devoted to a discussion of wild life photography.

"Gentlemen, Mr. Jones has consented to give us a talk tonight on the subject of our meeting, and he has brought along some sketches of devices as well as some films of birds and animals. Mr. Jones—"

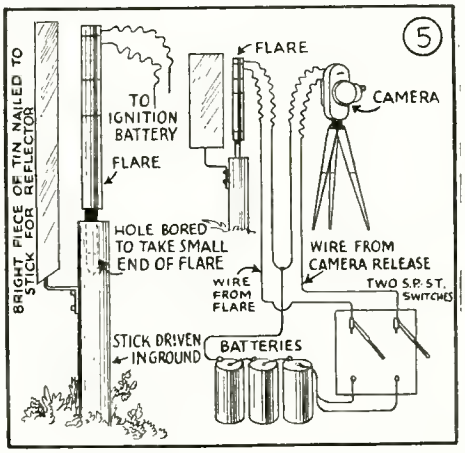
This from the Chairman.

"Mr. Blake, and gentlemen. It always gives me pleasure to talk before the Club, because when your films return from the processing stations, I notice that you have been trying the tricks I explain at the meetings, and I also notice a genuine improvement in your general work.

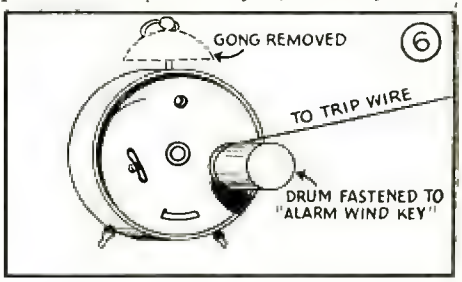
"In wild-life photography, we are able to make our films approach more nearly the perfection we seek in our home reels and photoplays. Animals will not act, especially the wild ones, and the few tame animals that you catch in cute tricks are really acting natural. The only difficulty about wild animals is that they must be persuaded to pose for you, and they won't do it voluntarily. Therefore we must get them unawares and the best way is to use the hunter's blind, if we know that we can find our actors at a certain place. There are many kinds of traps and I have



The above drawing shows how a magnet is used to operate the starting button when intermittent operation is required.



When taking movies at night, the flare can be lighted and the camera started at the same time, by using two single-pole, single-throw switches, as shown above.



If a roller is mounted on an alarm clock wind key handle and the string from the trip wire wound around it, the alarm will be partially wound when the wire is struck.

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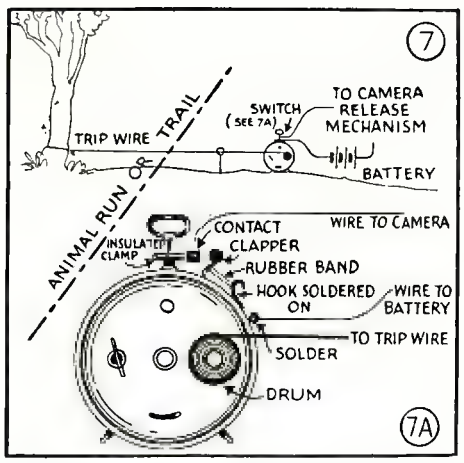
How to Photograph Animals, Birds and Fish

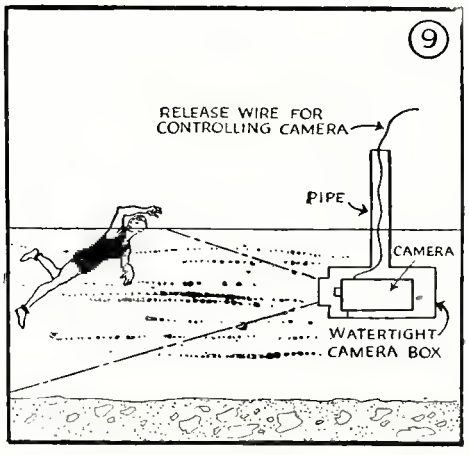


When using an alarm clock, the spring resets the trip wire and releases the camera. This continues until the camera runs down.

for "stop-motion" work, but is ideally adaptable for our purpose. It can be operated by a string from almost any distance and could even be hooked up to a magnetic release. It comes under the classification of "intermittent." Then we can provide a weight, to be released from a distance (Fig. 2) that will press the button and keep it pressed until the spring runs down.

"The simplest of all of these releases has a weight suspended over the button and held up by a string running to the operator. This, with a good pulley system, might even be intermittent in operation. Then we get into the electrical systems, where a battery supplies current to a magnet that operates the release button. There are several indirect ways in which to apply this magnetic force, because for economy's sake we must use the magnet to release other forces. For continuous operation we can release a weight magnetically (Fig. 3), or by using a lever we can operate intermittently (Fig. 4).

"With these devices it is best to fit them to the tripod rather than to the camera, as that obviates marring the surface of the camera case with attachment holes. It is essential to use a tripod in making trap pictures, especially with a telephoto lens. For that matter, a tripod should be used for every shot except in the case of rapidly moving objects. Then freedom of movement is desirable.

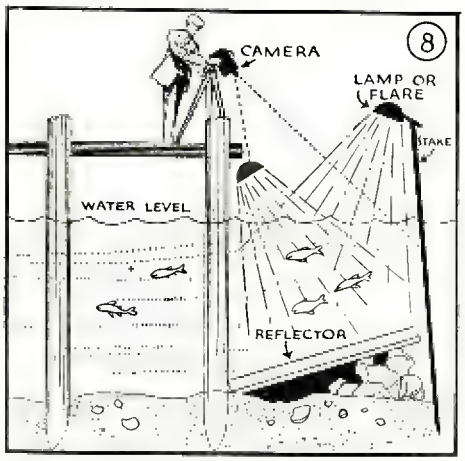


Under-water pictures of swimmers can be made by placing the camera below the surface of the water. The camera should, of course, be contained in a water-tight covering.

"Long focus lenses up to about three inches focal length *can* be held in the hand, but even with the three inch focus lens wobbles and involuntary body movements are magnified, with unpleasant results on the screen. The hunter's lens kit should include a wide aperture lens of f 1.5 or f 1.9 speed and one inch focal length, a three-inch or four-inch f 4.5 and possibly a six-inch. When using the six-inch an absolutely rock-steady tripod is essential. These lenses give rather a large range and should fit every contingency. K1 and K2 filters are desirable although not necessary and a focussing mount for each lens is an asset. A range finder or tape is also a handy piece of equipment and an exposure meter is almost a necessity.

"When you plan to take night movies on animal runs you should get a stock of flares, preferably the electrically ignited kind. Then by using two single-pole, single-throw switches you can light your flare and start your camera at the same time (Fig. 5). These flares are made of magnesium and are sold according to the length of time it takes them to burn. The shortest is one-half minute and they go up to four minutes in one-minute steps. They can be had for either match or battery ignition, but for wild game work the electric type is by far the better.

"When you do not care to watch your trap, a trip wire can be set up that will close the switch to take a few feet of film exposure or to run the camera until the spring is exhausted. If you care to construct a device that will photograph every animal that comes along the trail, in order as they appear, simply call out our faithful friend, the ubiquitous alarm clock. The idea is this: if we stretch our trip wire across a path, an animal coming along the path will strike the wire, hesitate a second, and then either step over the obstruction or retreat. We want to get his lingering and his advance or retreat. If we mount a roller on our clock "alarm wind" handle and fasten our string from the trip wire around it, when the wire is struck the alarm will be partially wound up (Fig. 6). Tension on the winding key with the clapper brake "off" will cause a movement of the clapper of the alarm bell. If this movement of the clapper closes a circuit that operates our camera release we will have a period of operation of our camera depending on the distance the trip wire was stretched. The clapper of the bell should be held back with a rubber band and the contacts adjusted so that the slightest movement will close the circuit. Then, if the animal pauses a few seconds, he will move the wire enough so that the contact will be made and we will have a picture of him investigating these "suspicious circumstances." Then, no matter whether he moves ahead or retreats, we have a picture of his movements. Of course, the apparatus must be carefully adjusted so that we shall not waste film. The advantage of using the alarm clock is that when the spring returns to its normal position, it resets the trip wire, releases the camera and all is ready for the next shot (Fig. 7). This continues until the camera runs down. The idea could even be adapted to night work by having a magnetic selector to pick out each flare in turn for ignition from the common battery. That ,however, is another story.



The above illustration shows how to take moving pictures of fish by suspending lamps close to or in the water. A reflecting surface is arranged about four feet below the surface of the water.

"Bird life is always a fascinating study and many interesting motion pictures of birds have been made. One of the most beautiful bird films I have ever seen was made some years ago by a German professional company showing a slow

(*Continued on page* 187)

Photo courtesy Movie Makers.

Above is a photograph of a bear taken as he retreated from the cameraman.

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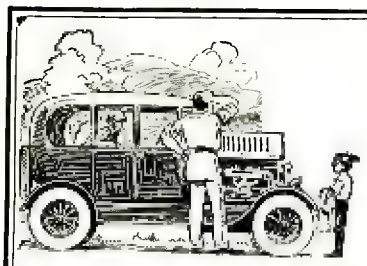
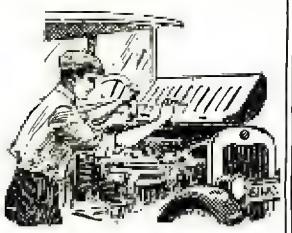


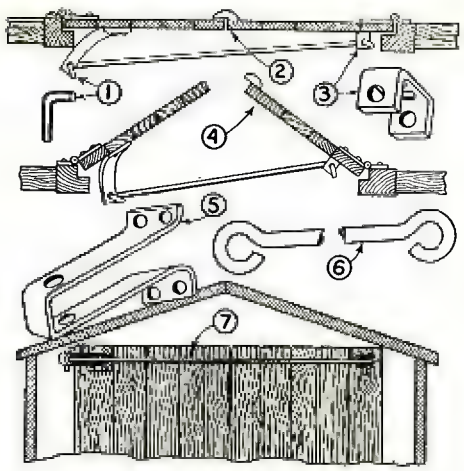
Motor Hints

Conducted by
GEORGE A. LUERS



Valuable pointers for the car owner assist in keeping the auto in condition

Connecting Link for Garage Door



In the above illustration, 1, is a pivot rod; 2, shows closed position of doors; 3, hinge bracket; 4, doors partly opened; 5, offset hinge bracket; 6, connecting link; 7, connecting link placed inside and at upper edges of doors.

AS a means for quickly opening garage doors of the hinged type and also to prevent them swinging prematurely closed, the linked attachment shown in the attached illustration, will prove to be a useful fixture.

This is made from sheet metal, bent to form two hinging brackets, and a piece of iron rod about seven and a half feet long. This rod is bent at the ends to form eyes. Small rods through the brackets, connect the link rod to the doors.

Opening one door swings the opposite door open.

DO YOU KNOW—

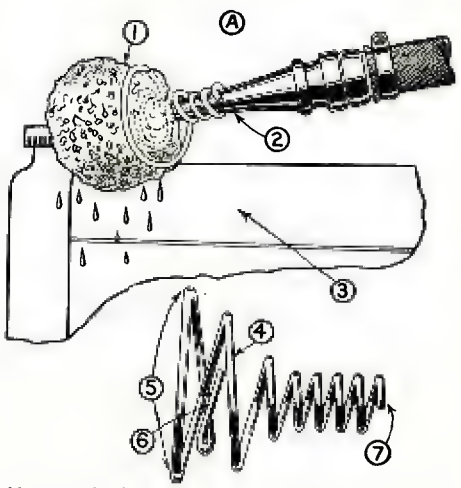
A car with an entirely depleted battery, or a car in which there is a break in the electrical circuit, can be started with the battery from a flash light. Connect one circuit to the spark coil terminal and ground the opposite side of the circuit.

Sponge Holder

ALMOST every car owner is aware of the damage done to automobile paint when the hose is turned on with unbroken force. To sponge off the body, with a pail of water and sponge, is both slow and laborious.

The simple means devised by one motorist of combining a sponge with the hose, through use of a brass spiral wire holder, solves the problem of washing fast and easily.

The sponge, as shown in the sketch, is held to the hose nozzle by means of a piece of brass wire in the form of a spring.

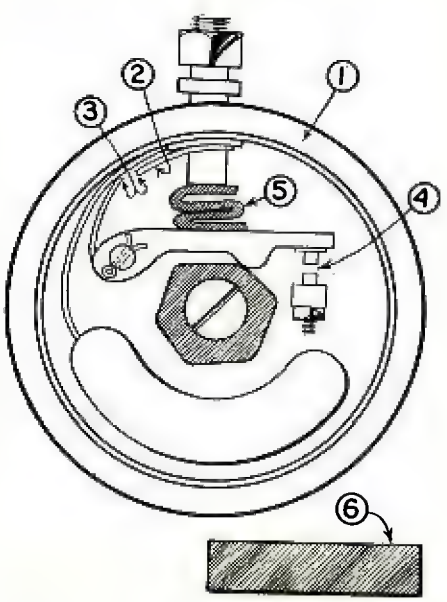


Above—A, illustrates how paint of car is not damaged when using the described device; 1, large sponge; 2, hose nozzle; 3, engine hood; 4, brass wire; 5, coil to fit over sponge; 6, end of coil; 7, small end fits over hose nozzle.

Repair for Spring in Breaker Contact Arm

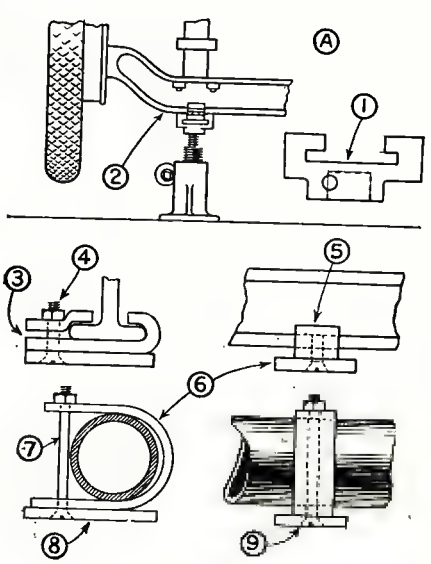
THE trouble of a broken spring in the distributor breaker arm is not frequent, however this may happen to almost any car. The emergency repair means shown by the sketch to overcome this difficulty is of more than usual interest, inasmuch as the owner who resorted to this brought his car some fifty miles successfully, before encountering a garage where more serviceable repair could be made.

This repair brings to mind a similar repair with rubber, which is worthy of noting. In this instance, one of the clips holding the distributor head broke.



Above—1, view of breaker mechanism; 2, spring; 3, point of breakage; 4, contact point; 5, rubber pad as an emergency repair for broken spring; 6, strip of rubber which is folded to form a spring cushion.

Special Jack Head



Above—A, method of preventing jack from toppling over; 1, head of jack slotted; 2, section of front axle; 3, fastener for front axle; 4, bolt; 5, fastener for rear axle; 6, strap iron; 7, bolt; 8, rear axle fastener; 9, side view of fastener.

A CLEVER idea of one car owner who solved the problem of preventing the jack from toppling, is shown in the accompanying sketch.

The owner, being mechanically inclined, and handy with tools, made fasteners for the axles, as shown in the sketch. He made also a special head for the jack, having a "T" slot to engage these fasteners.

Close inspection of the sketch will show that the "T" slot on the jack engages the strip under the axle. The jack is unable to tip over, being restrained by

(*Continued on page* 182)

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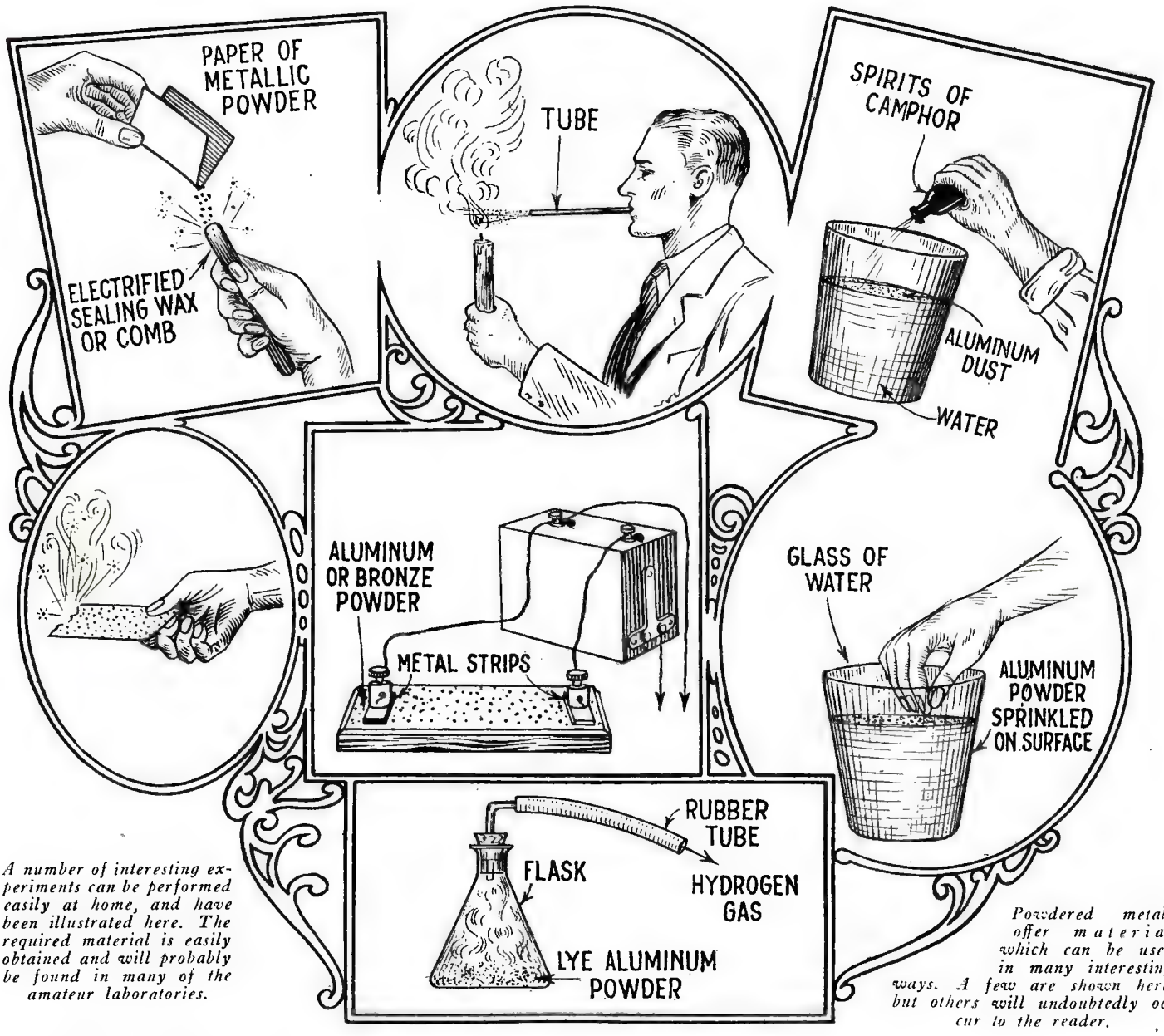
CHEMISTRY And ELECTRICS

Experiments with Powdered Metals



A number of interesting experiments can be performed easily at home, and have been illustrated here. The required material is easily obtained and will probably be found in many of the amateur laboratories.

Powdered metals offer material which can be used in many interesting ways. A few are shown here, but others will undoubtedly occur to the reader.

I WOULD not like to have a pound lump of iron thrown at me, but you can throw a pound of powdered iron, and I will not mind it as much as I do rain. You can throw a block of iron in a flame with no result, but the same block, finely powdered by filing or grinding, and thrown into the same flame will cause a wonderful flare-up. Truly, metals act in a different manner when they are finely divided than when in large pieces.

The sweepings or "dirt" about a grindstone or emery wheel consist largely of powdered iron. This mass when freed of the adhering oil by washing in gasoline will afford much fun by dusting it into flames. The iron becomes heated to incandescence and combines with the oxygen of the air to form iron oxide with the subsequent production of heat and light.

Powdered aluminum or aluminum "bronze" powder such as sold to be used in aluminum paints will give an exceedingly bright flash when blown through a flame. A glass tube or soda straw partially filled with this powdered aluminum will serve one as an emergency flashlight for night photography. The loaded straw is aimed at the flame and the contents blown into it with a light puff. The aluminum burns with an intense white flame, leaving white specks of aluminum oxide floating in the air after the experiment. A very simple variation on this somewhat spectacular experiment is to sprinkle some of the aluminum dust on a sheet of paper and ignite the paper, holding it in the hand.

For a more intense and practical white light for signalling or photographic use, the following mixture will give excellent results: barium nitrate 38 parts, powdered aluminum 5 parts, flake aluminum 4 parts, vaseline or castor oil one part, flowers of sulphur 2 parts. This composition is ideal where a case or box of the substance is to be made, for the oil prevents the flakes from sifting to the bottom of the igniting case. If the powder is to be sprinkled upon the ground and ignited, the oil or grease can be omitted.

Two things usually happen when your hand is thrust into water—your hand becomes wet and the water becomes dirty (?). If powdered aluminum is sprinkled over the surface of a vessel of water and the hand thrust into the water, the aluminum dust will coat the surface of the hand and act as a protective layer so that the water will not wet it. This can be repeated as often as desired. The (*Continued on page* 186)

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Should the Amateur Build a Glider from Blueprints?

The Negative Argument Set Forth

By PROF. P. ALTMAN,
Dept. Aeronautical Engineering
University of Detroit

The Positive Argument Will Appear Next Month

A GLIDER is essentially an airplane in which the motor has been omitted. Its construction and aerodynamic features are similar to the airplane and require as much care and thought as the design of a powered machine. In some cases the structural features of a glider are even of greater importance than those in an airplane. This is due to the fact that the builder aims for extreme lightness and when such levity is obtained, particular attention must be given to the strength of the structure from the viewpoint of handling on the field and irregular flying. A condition may arise where a part of the structure has been calculated to have a good margin of safety under direct stress, but to be extremely weak to stresses acting obliquely to its principal axis. As an illustration consider the case where the front spar is made of a high depth to width ratio, such as 10 or more. The spar will be found to be strong even in direct bending, but unstable about its minor axis under compression. Thus it is apparent that the glider is not in the class of a toy and not for the inexperienced person to build.

Weakness of Blueprints

IT readily can be seen by anyone familiar with aircraft construction that the mere supplying of blueprints of a glider does not mean that another glider can actually be built from them. To construct a glider from blueprints, even if they are accurate and complete, requires that the builder have a good knowledge of aircraft materials and aircraft construction. It has been my experience that even with the best of blueprints, serious errors were made by certain shop workmen, who undertook aircraft construction for the first time.

Usually a set of blueprints is accompanied by a set of specifications covering the materials necessary in the construction of the glider. This in itself is not sufficient unless the builder can judge the quality of materials required for its construction.

Quality of Materials Important

ONE set of blueprints that I had the opportunity to examine simply specified cold-rolled steel for all fittings. Now cold rolled steel does not define the composition or the physical state of the material, which may be anything from very mild steel to very hard steel. If the latter is chosen and used in fittings requiring 90 degree bends, the builder will find that the material either will crack during the bending, or else break in service, when some crack is not detected. Should this occur in a primary fitting, a serious accident may result.

A similar situation also exists in the selection of wood of the proper quality. Unless he is qualified to judge the condition of the wood, inferior material may be used in such parts as the spars, longerons, struts, etc., and consequently may be the cause of a serious mishap that could have been avoided by proper supervision.

Expert Aid Highly Desirable

NO doubt there are glider clubs in our universities which are capable of preparing their own blueprints and building a glider from them. However, it will be found that these clubs usually have some members who have had considerable aircraft design and constructional experience. If such is not the case, there is a member of the faculty who, from his enthusiasm for this sport, is supervising the work. There is always someone who really knows.

But with clubs composed of boys from 15 to 20 years of age, experienced workers are lacking. These youths may show much enthusiasm and desire to learn, yet to do so successfully they must work under the supervision of someone trained in this phase of the work. If a group is in close proximity to some aircraft plant, they usually can interest some of the technical men in this plant to aid them in their undertaking. Then the club can construct its own glider.

An indirect objection to the building of gliders by clubs whose members range in age from 15 to 20 years, is that when the club is organized, a great amount of enthusiasm is shown by all. Dues are paid immediately, plans are formed, materials ordered and the work is started with a rush, but within a short time the enthusiasm wears off. The boys want to fly and not spend their hours in the shop, so one by one they drop out of the shop program and soon all work is left to the willing few. The remaining ones also become discouraged, the plans are discarded, the money is practically lost, and they are without a glider.

"Gliding" Spreading Rapidly

GLIDING is spreading so rapidly in this country as a sport that we must not be misguided by our enthusiasm and risk the popularity of such an interesting outdoor diversion by encouraging people to build gliders who are not really capable of doing so. To make a glider properly not only a technical advisor is necessary, but also access to adequate shop facilities in which workmanlike results can be obtained.

Hence, if gliders are to be built by individuals or clubs from blueprints furnished by some central organization, the seller should be certain that his blueprints are complete and correct. Secondly, that those desiring the prints should show from previous experience that they are capable of following the blueprints, understand other details necessary to insure a safe glider, and have the proper facilities at hand for its construction.

Further, any central organization undertaking to supply blueprints should first have a glider built from their blueprints by a personnel of similar ability and experience as those to whom they wish to sell them. The personnel could consist of some club or school group in its vicinity. This method would assure them that the blueprints are sufficiently accurate and complete for the non-technical worker.

In general, it is the opinion of most engineers, with whom I have discussed this problem, that blueprints for the construction of a glider, no matter how complete, should not be sold or otherwise furnished to any individual or clubs unless they have someone in their organization with sufficient technical and shop training to guarantee that the glider will be built in a workmanlike manner in accord with these blueprints and specifications.

From the above-mentioned reasons we may safely conclude that the amateur should not attempt to build a glider from blueprints, although it may seem an easy task.

TWO SIDES TO THE GLIDER BUILDING STORY

GLIDER-BUILDING from blueprints presents an argument that has both proponents and opponents, as we might well expect. Those who are against the building of gliders from blueprints, by amateurs who have had no flying experience, are arrayed against an equally enthusiastic group who believe that it is perfectly feasible and desirable that the embryo pilot should and could build a glider from blueprints. It is not our intention to take sides in this argument, and we will publish blueprints showing the dimensions of successful gliders. It goes without saying, of course, that if you can obtain the advice or assistance of an experienced aviator in building and flying your first glider, by all means do so. Next month we shall present the positive argument for glider building from blueprints.—EDITOR.

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How to Build a Man-Carrying Glider

By MARVIN A. NORTHROP

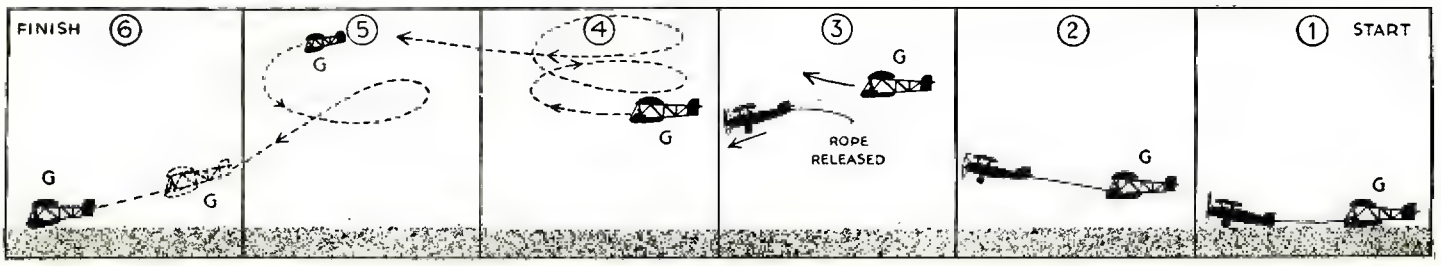

Fig. 2—The above illustration shows successively the steps in the launching of a glider by means of a motored plane. The glider is fastened to the airplane with a rope and when sufficient altitude has been gained, the rope is released as shown.

THOSE familiar with Greek mythology will undoubtedly remember among the legends a story of Icarus and Daedalus and their flight from the island of Crete. Daedalus incurred the disfavor of Minos, the king, and in order to escape made wings for himself and his son, Icarus, from feathers which were fastened with wax. This is probably one of the first accounts of the flight of man. Leonardo di Vinci, the great Italian painter, in the year 1500 made a study of aircraft and constructed models that lifted themselves in the air mechanically without employing gases of any sort. Nearly all of the early experiments were made with "ornithopters" or the flapping wing type planes. Di Vinci planned the helicopter which is a vertical lift type of craft. Until 1840, however, the majority of inventors continued to study the flight of birds and wrote essays on that system of mechanical flight.

Gliders

ALL of the early pioneers in the history of aviation, employed gliders experimentally to obtain knowledge of wing forms and to ascertain the effect of wind current on the wings and control surfaces. The art of aviation was not an exact science, and the airplane was only made possible by developing the fundamentals from glider experiments. The glider offers a means for the beginner to familiarize himself with the controls and also affords experience which will be valuable when flying a motor powered plane. The principles of flight are readily demonstrated by the glider but not only this alone recommends the motorless craft to the amateur aviator, for glider flying is an interesting, thrilling and enjoyable pastime.

Details for Building a Motorless Plane Which is a Duplicate of the German Gymnich Sailplane

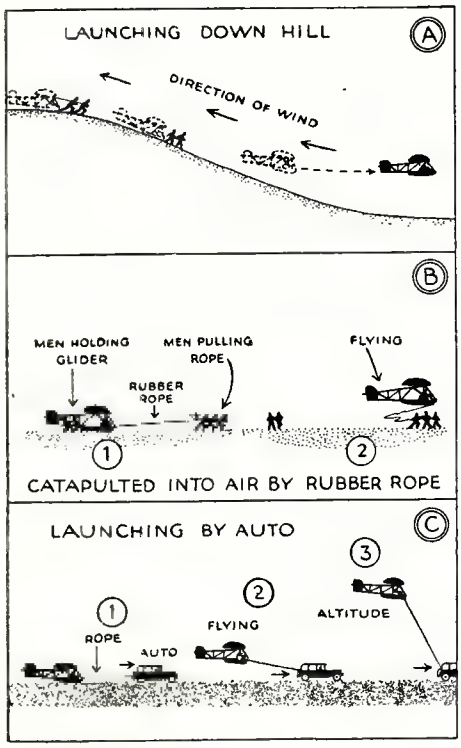

Fig. 1—In the above illustration A shows how a glider is launched downhill, B, manner of catapulting into air by rubber rope, and C, launching with automobile.

Man Carrying Glider

CONSTRUCTIONAL details and full working drawings are given here so that anyone can build a man carrying glider in a workmanlike manner and produce a product which compares favorably with a factory built machine. It is best to assemble the plane as the work progresses and leave it uncovered, for if there are any faulty joints or if any mistakes have been made, it is much easier to rectify them than if the glider were covered.

Construction and Specifications

THE runner shoe and clamps should be of sound, straight grained, quarter sawed, kiln dried ash. The spruce used throughout should be U. S. Gov. specification Sitka spruce, straight grain, and sized to the correct dimensions. The lower member of the runner should be steam bent, care being taken not to "burn" the wood in steaming.

The struts should be stream line shaped, between end plates as indicated by small sections on the drawing. The rib stock is to be specially selected for straight grain and accurately cut to size.

The plywood is to be birch "Haskelite" or equal. The short bends for the nose of the rudder and wings may be made by dampening the plywood before application. The plywood should be bent parallel to the surface range.

The air foil jig is made on a true, flat, wooden surface. The outline should be true to 1/32 inch of the measurements given for the airfoil. Fasten ¼ inch by 3/16 inch strips to the wood plate to give outline "in negative" of all members. Cut accurately and lay all members of the first half into the jig. All joints should be glued and glue should be used freely on the "gusset" plates of the plywood. When the glue is set, remove and glue onto the other members when properly fitted into jig of reverse pattern.

In making the wing assembly, lay out spars and drill for all fitting bolts. The ribs should be slid into position with bolt fittings in place. They are then aligned and the ribs glued to spars shimming where necessary to get a solid bearing. The "trailing edge" strip should now be inserted and glued in place. The bracing wires are next cut and assembled and the wires tightened and wing aligned true to ⅛ inch. The aileron control cables and pulleys may now be installed.

The aileron ribs are made in the same manner as the wings. The ailerons are assembled and attached to the wing spar with hinges and are subsequently covered with fabric.

Covering

ALL surfaces except the nose should be covered with "A" grade mercerized cotton drawn tight and cemented at all edges to the framework and to the ribs on rear half of lower surface with aircraft dope. The nose is covered with plywood, bent to shape, glued in place and bradded with cigar box nails to "filler strip" on the top and the bottom of spar between ribs, bending forward edge of fabric. The covering is punctured at the proper points for guy wires and control cables. These punctures should be reenforced with patches. Instead of mercerized cotton any other approved airplane fabric can be used. Two good coats of approved aircraft dope should be applied with at least two hours time allowed between the coats. The tail surfaces (rudder, stabilizer, (*Continued on page* 139)

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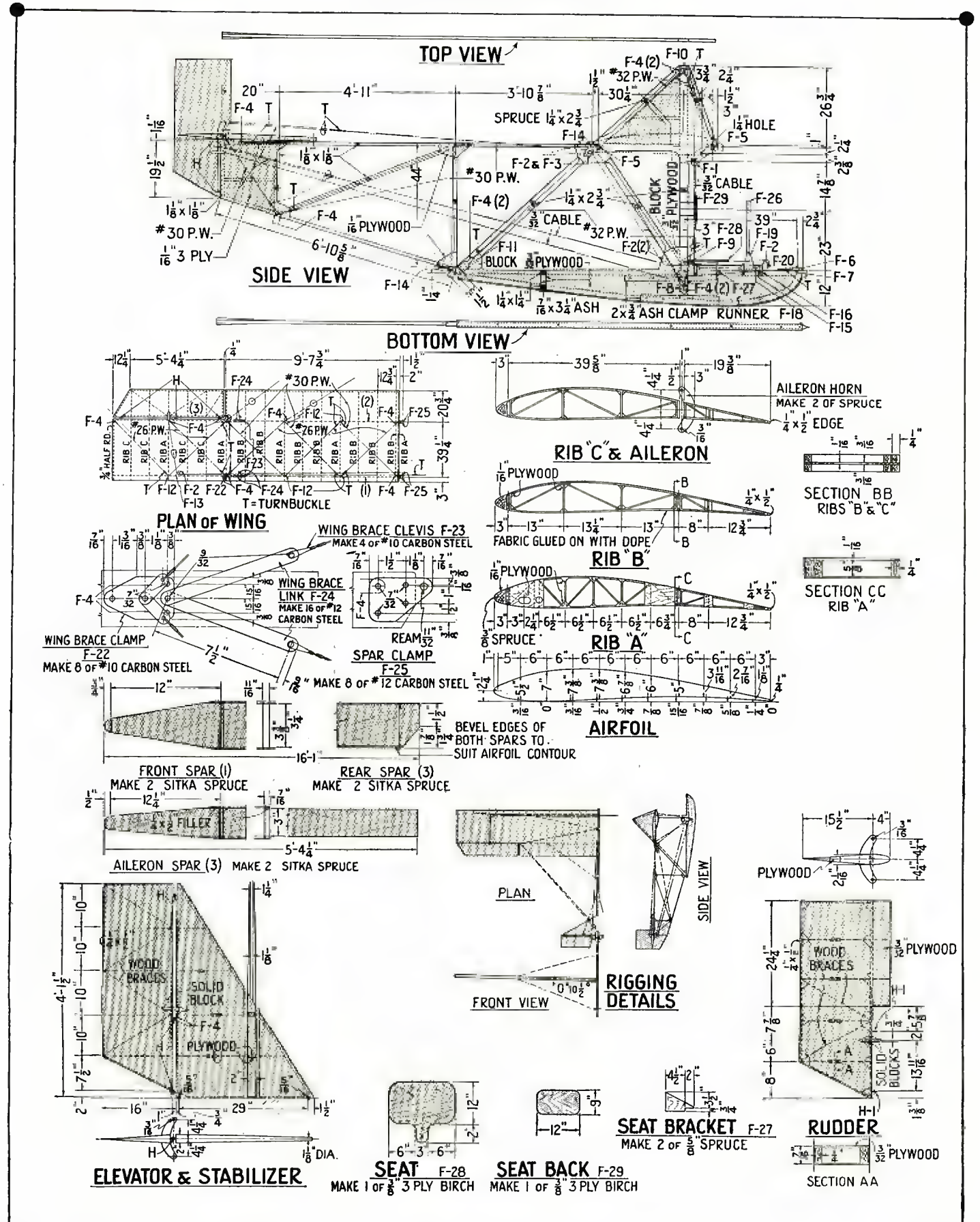
DETAILS OF MAN-CARRYING GLIDER

By MARVIN A. NORTHROP

(Diagram for article on preceding page)



The above drawing gives all the details for building a man-carrying glider. Plans for the fuselage, ailerons, wings, elevator and stabilizer are given. Further details next month.

Dimensions for the rudder and seat appear here, together with details of the rigging and other appurtenances. The constructor should have no difficulty in following the plans given.

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How to Build a Man-Carrying Glider

By MARVIN A. NORTHROP

(*Continued from page* 137)

and elevator) are made of similar material in a similar manner, aligned, covered and doped, the same as the wings.

Fuselage

ALL members of the fuselage are made as shown and are laid out according to dimensions. All joints should fit accurately and should be glued together with the necessary blocking and stiffening. Cover runner, tail fin surface, pilon, and "gusset" plates at joints with plywood as noted and glue together. All fittings should be applied and bolted in place.

Miscellaneous

THE glue used should be of the best grade government specification casein, water-proof glue and is applied hot.

The fittings are to be made accurately as shown and of the material specified. The carbon steel should be annealed before bending and tempered afterward.

The bolts are to be carbon or high tension steel threaded S.A.E. or U.S.F. 32 thread for 3/16 inch bolts. After tightening the nut, the bolt should be cut flush with the nut and "rivet" (to prevent loosening) with four center punch identations in thread circle.

The wires should be piano wire looped through the fitting, "safety" secured and with the loose end doubled back.

The control cables are to be seven strand, flexible wire, cord looped through fitting with "thimble insert." Bind loop with copper wire binding sweated with solder, double back loose end and bind.

The pins for the hinges and doubled links are of carbon steel of proper length and secured with aircraft safety pin or cotter pins.

The turnbuckles are to be standard type of correct size to develop full strength of wire or cable and after tightening secure from turning with copper wire lacing.

Assemble all units of the rigging properly and connect securely. Tighten guy wires, stays and braces so that wings and stabilizer will be straight, level and at right angles to fuselage. Adjust control wires so that, when all controls are in "neutral," the ailerons conform to the wing shape and the elevator center line conforms to the stabilizer center line.

Fig. 3. The above photograph shows a glider similar to that described here but without the pilon. The group of assistants are launching the plane with a cable while they run downhill. This is one of the methods which can be used for getting the glider into the air.

Launching

THERE are five ways in which the completed glider can be launched. Three are illustrated in fig. 1. Illustration A shows perhaps the simplest manner which consists in having two assistants pull the glider to the edge of the hill, and as the pilot feels it rising up, he signals to the assistants to let the craft free. The launching should be done flying into the wind. A glider can be catapulted into the air by using a rubber rope as shown at B. A number of assistants pull on and stretch the rubber rope as shown in position 1, and the craft is snapped into the air as shown at 2. Launching the glider with an automobile is illustrated at C. The glider is attached to the automobile with a rope and when it gains altitude, the rope is released.

Fig. 2 shows successively the stages in launching a glider with a motored plane. A rope connects the two aircraft and when the glider gains altitude, the operator releases the loop and continues his flight unaided. Fig. 3 shows a glider being launched by pulling down hill.

Navigation Knowledge

THE pilot of a glider should understand the weather conditions which influence the air currents, and also, the conditions that produce a deflection of the air currents from the ground and cause them to travel upward. Experienced pilots can actually use air currents to advantage and gain altitude in this manner. The highest record has gone over 2,500 ft. and flyers have remained 15½ hours in the air, covering more than 40 miles measuring from the point of starting. In circling flights much greater distances have been covered. In Germany, transport companies require pilots to be experts at soaring and they must prove their proficiency in the manipulation of the glider, so that they can take advantage of available air currents and so that they will be able to make safe landings in case of motor failure.

The dangers in learning to operate gliders are not great as there is no heavy motor, and especially with a wind blowing up the slope of a hill, the glider will not move very fast over the ground. In selecting a launching field, it is best to find a hill which slopes in many directions, so as to take advantage of winds blowing from different points. For soaring, a long ridge or cliff is a more suitable position from which to start the flight. If the specifications given here are followed religiously, the constructor will have a staunch glider which is easily controlled. There is hardly another sport which contains so many thrills, and yet, which can be taken up at the reasonable cost of about one hundred to one hundred and fifty dollars.

How Gliders Are Supported

AN idea of how a glider or an airplane can be raised against the force of gravity and sustained in the air requires, first of all, an appreciation of the weight of the atmosphere without which no plane could ascend. What is felt as the force of a strong wind is the impact of a definite weight of air against the body. The weight of any volume of air varies somewhat according to the temperature and barometric pressure. If a metal weight is thrown against the underside of an inclined sheet of metal, this sheet will be moved upward and backward. If the same weight were projected from a gun, and did not perforate the inclined plate, it would be thrown upward and backward much further. Exactly the same principle applies when the metal weight is represented by the air and the inclined plate is the wing surface of a glider. Part of the force of impact which is effective in an upward direction is termed the "lift." It is supplemented by a reduction of pressure on the upper surface of the wing. The remaining force that continues in the direction of the impact is the resistance and is called the "drag."

The study of forces exerted by air moving against surfaces of various shapes and sizes is called aerodynamics. More technically, the lift exerted on the plane is due to the dynamic reaction of the atmosphere against the lower wing surfaces. The principles of aerodynamics are the same if the supporting surfaces are held in a current of moving air or are propelled through still air. A kite cannot fly in still air unless it is towed by running or otherwise. Models of planes or wings are employed extensively in research work in wind tunnels and are acted on as kites are affected by wind.

Names and addresses of people supplying blueprints of gliders will be furnished upon request to the Editors.

(*To be continued*)

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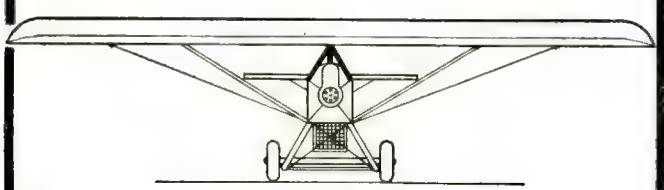
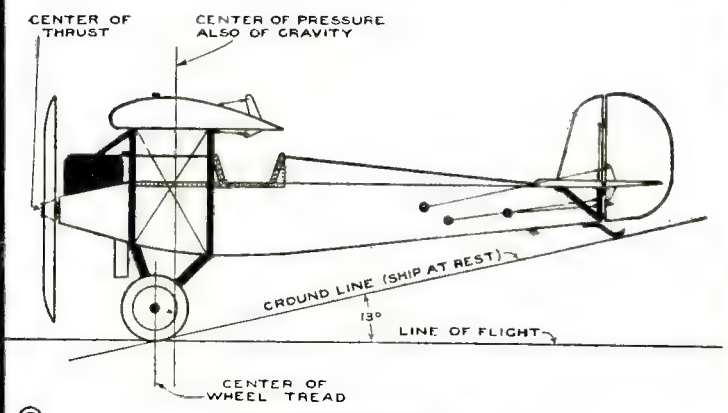
Details of Single Place Monoplane



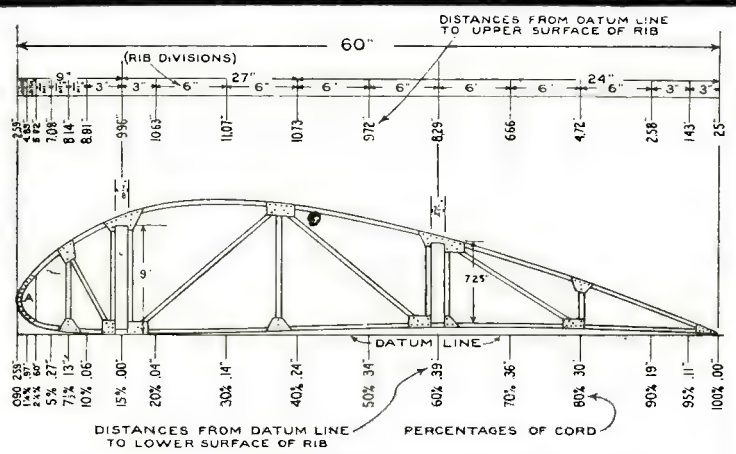
① FRONT ASSEMBLY

A view showing the front assembly of the plane appears above. The best plan is to build up the whole ship and assemble it as built, uncovered. In this way, a good fit is assured without the delay and nuisance of uncovering to correct a fault in the construction.



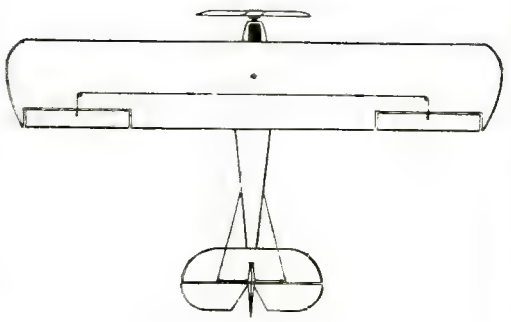
② SIDE ASSEMBLY

The side assembly is shown above. There are many details of assembly which could not be mentioned in an article of this size because space would not permit. The constructor will do well to study the drawings and use a little ingenuity.


DISTANCES FROM DATUM LINE TO UPPER SURFACE OF RIB
60"
(RIB DIVISIONS)
DATUM LINE
DISTANCES FROM DATUM LINE TO LOWER SURFACE OF RIB
PERCENTAGES OF CORD
RIBS MADE UP IN JIG, SO THAT THEY ARE ALL ALIKE, OF 5/16" X 5/16" BASSWOOD OR SPRUCE - GUSSET PLATES ON BOTH SIDES OF .020" FIBRE OR 1/16" PLYWOOD. - WATERPROOF GLUE AND NAIL WITH 3/8" X 20 GAUGE NAILS. - WOOD FILLER BLOCK AT "A"

④ U.S.A.-35-A-RIB AND JIG LAYOUT

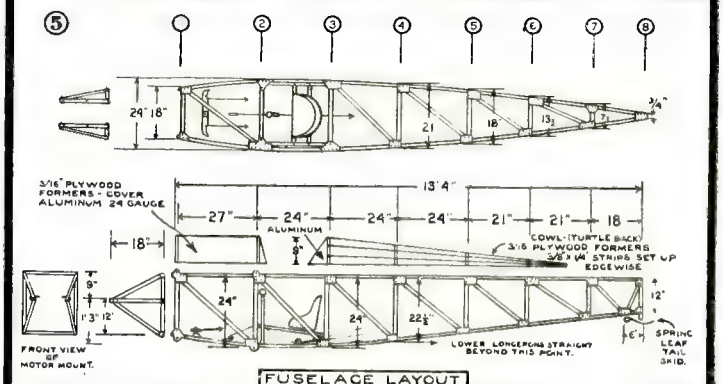
The rib and jig layout is shown above. From this drawing any sizes of ribs for various types of wings may be calculated.



③ TOP ASSEMBLY

The top assembly is given here. It must be remembered that all fits should be perfect for maximum strength. Ailerons should be built with good clearance, eliminating the chance of jamming.

IN building an airplane, it is undoubtedly best to first construct the wing. Fig. 4 shows how the ribs are made up in a jig, so that they are all alike. Basswood or spruce is used. The rib should be lifted vertically off the jig when finished, leaving nails in the wooden base for forming the next rib. The wing assembly is to be shown in detail and no trouble should be experienced. By building the wing in one straight panel, a more rigid job is secured. Five ribs on each end are cut for ailerons. After the ribs have been put in place and glued and nailed, the compression members may be installed.


3/16" PLYWOOD FORMERS - COVER ALUMINUM 24 GAUGE
ALUMINUM
COWL (TURTLE BACK)
3/16 PLYWOOD FORMERS
3/8 x 1/4 STRIPS SET UP EDGEWISE
FRONT VIEW OF MOTOR MOUNT.
LOWER LONGERONS STRAIGHT BEYOND THIS POINT.
SPRING LEAF TAIL SKID.

⑤ FUSELAGE LAYOUT

The fuselage layout appears above. When assembling the fuselage, it is a very good plan to draw the full-sized outline on a wooden floor or side of a building and nail blocks for a simple jig.

ATOP, side and front assembly are shown here, together with fuselage and rib and jig layouts. There are, of course, many details of assembly which are not mentioned as space will not permit. However, after studying the drawings, the builder should have no trouble in completing the plane. The plane described here, a monoplane of the parasol type, is perhaps the most stable yet developed. The ship has proven to be non-stalling and non-spinning, a test having been made with the tail dragging at angles varying from 16 degrees to 25 degrees. Under these conditions there was no tendency to stall.

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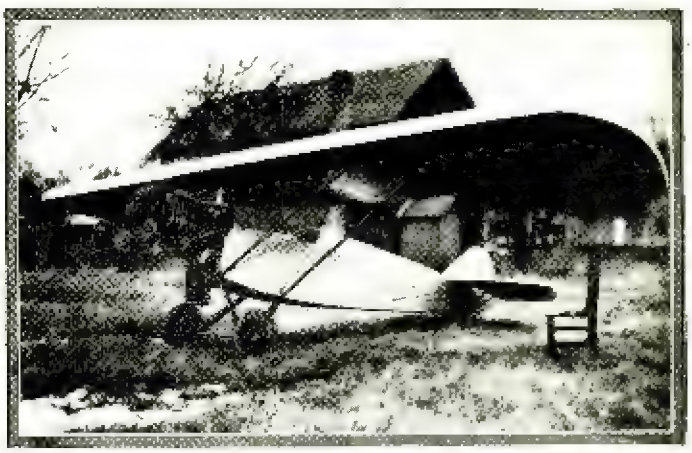
Details of Home-Built Monoplane Powered by Chevrolet Automobile Engine

How to Build Your Own Airplane

PART I

By GEORGE A. GERBER



A three-quarter view of the airplane built by the author is shown in the above photograph. The monoplane furnishes a good training ship, mainly because of the visibility afforded.

FIRST I wish to make it perfectly clear that there need be no mystery whatever attached to the building or flying of an aeroplane, in the mind of any person of average intelligence.

A reasonable knowledge of theory of design, construction and flight is comparatively easily obtained, by a half hour in evenings, spent in real study of some accepted works — such as Rathbuns "Aeroplane Construction and Operation" — the 1918 edition being especially good, as it covers the whole field in detail, and it is a duty one owes oneself to become acquainted with this most modern of man's industries.

MONOPLANE DESIGN APPROVED BY EXPERT

MR. AUGUSTUS POST, one of the leading and best known authorities in America on aircraft, has looked over the design drawings and data accompanying this article on a home-made man-carrying airplane, and he has approved this design as a thoroughly workable aircraft.

Several important rules should be carefully kept in mind before the builder of this airplane shall attempt to fly it off the ground.

1. The builder should have attended a flying school or else had the benefit of instruction by a licensed pilot, and he should not attempt to fly this plane off the ground until he has been approved by an experienced and preferably licensed pilot.

2. Also, in many states there are special laws governing the flying of a plane, whether home-built or manufactured by one of the regular aircraft companies, and the builder of such a plane as this one should take up the matter of "flying" and "plane" licenses with his local government authorities. The nearest motor vehicle license bureau will usually have the information, or direct you where to obtain it.

3. Before taking up any plane, particularly a home-built plane, the owner, unless he is already an experienced "solo" flier, should have an experienced pilot look over the plane in order to determine that the wings, for example, are thoroughly strong and that all guy wires and the landing gear, etc., are properly tightened up and that there are no weak parts in the plane.

4. It should be distinctly understood that SCIENCE AND INVENTION Magazine cannot be held responsible for personal injury sustained while flying a plane built after the specifications here set forth, for the very good reason that the publishers have had the design approved by a recognized expert on aircraft design, and if any accident should happen, it will usually be due to either one of two general causes:—first, due to some mistake of the pilot while in flight; or second, due to a failure of some part of the plane, which might be caused by improper construction, or else a poor grade of materials used in its construction.

"I HAVE APPROVED MR. GERBER'S DESIGN OF A ONE-PLACE MONOPLANE HERE DESCRIBED."

(Signed) AUGUSTUS POST.

Above—A side view showing the mounting of the wing.

I can truthfully state that a person of average persistence, with a dash of mechanical ability, one who can think for himself, dope out the little things that are not in blueprint form before him, can be reasonably sure of success in his undertaking of building an aeroplane that will fly.

Good workmanship is a requisite,—in so much that there is no intermediate form, — a piece of work is either right, or then it is wrong; for in this game it is an exceptionally dangerous practice to pass a job off the easy way, "guessing it's all right." In aviation things must be right.

In the flying end of the game, a person needs but be in good physical condition, alert, quick to learn, quick to apply what he learns, and comparatively free from nervousness.

I will not state totally free from nervousness, as I am positive that almost all real pilots will admit that they passed through at least a mild stage of nervousness on their first experience at the stick. It's human.

Most any one of either sex, who can drive an automobile, I mean really drive one, can learn to fly in from 8 to 10 hours of dual instruction, and many have soloed in less. Some exceptional types such as my instructor Aavang—taught himself to fly without dual instruction.

Perhaps it would be a good plan to tell you of my experience during flight training.

A great amount of my work has been done in partnership, (Just try and keep people from becoming interested when you really show something beyond dreams) and "our" first job was a Harley twin-powered sport biplane.

It did not get off, but it furnished us both with about 25 hours of "grass cutting," and a fairly decent feel of the controls and their action, as the little "bug" taxied at a speed of about 35 M.P.H., and had good rudder and flipper control.

Our second job was successful. We picked up a Jenny fuselage, with tail planes and landing gear attached, and O X 5 motor installed: built up a monoplane wing, same section as used in this job, high lift, thick wing, and mounted it parasol, 20 inches above the fuselage in (*Continued on page* 179)

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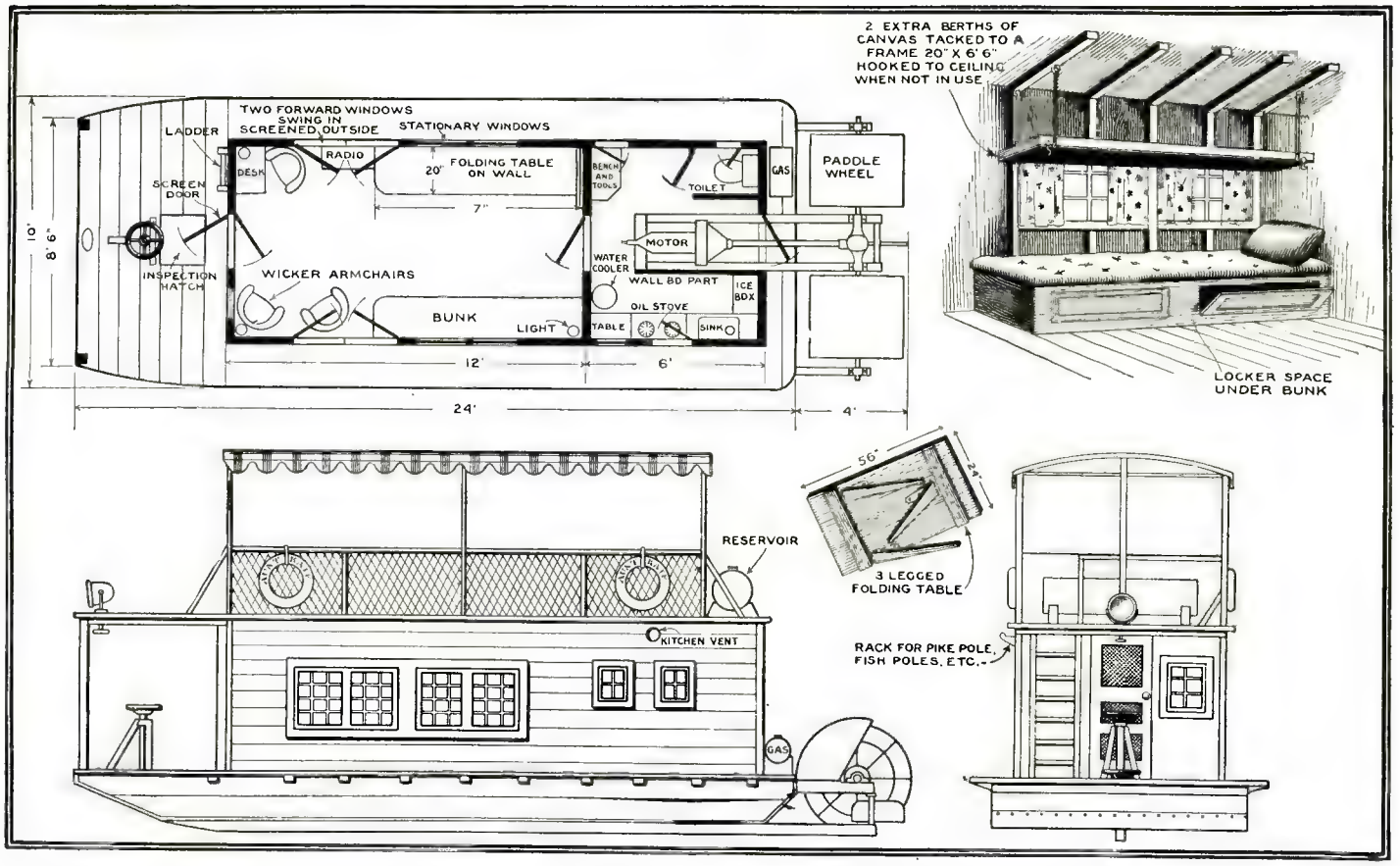

A top view showing the interior plan and space saving construction is shown, together with the completed boat.

A front view of the boat and the sleeping quarters are shown above. The cabin does not extend the full width of the scow.

A Stern Paddle Wheel Houseboat

By HI SIBLEY

FEW investments will afford more wholesome recreation for the entire family than the money put in a houseboat. The "Aunt Kate II" illustrated in these pages will cost money to be sure, but no more than would a small cottage with average equipment. It has the rare advantage of moving about at will, independent of a tow, into peaceful, shallow bayous where no other power craft would dare to venture.

It is interesting to note that where a generation ago power equipment would represent about half the cost of a similar houseboat, today an engine — particularly a used Ford Model T motor—can be had for little more than the cost of the necessary hardware. On the other hand lumber is proportionately higher.

This design was drawn up expressly for the man who has had little or no experience in building boats, and to whom only ordinary lumber and other material is available. The scow type was selected because of its practicability in shallow water where stumps and vegetation abound, and where the inshore is gradual. The worst that could happen to this sturdy type is running aground, though the mariner is cautioned against getting too far from shore in large lakes where violent and sudden storms are frequent. The boat, Aunt Kate II, will never be conspicuous for speed, but she *will* get there in her leisurely and sedate manner.

Note that the cabin does not extend the full width of the scow. This is for stability. In her predecessor we made the cabin *wider* than the scow, with the result that whenever there was a sudden shift of passengers to one side the boat gave a disconcerting list. That defect has been ably overcome in the new design.

In driving by two paddle-wheels through a differential there is a distinct advantage in turning short. Also, the rudder is placed well aft to give the best possible steerage. Paddle-wheel boats do not respond readily to rudders installed in the conventional location directly under the stern.

SIXTY years ago, a number of "keel-boats" operated on the St. Joe River, near South Bend, Indiana. These were ungainly, seaworthy, rectangular scows. The present houseboat, drawing only one foot of water, had its birth in the river scows.

Building the Scow

THERE is considerable work on the scow, but it is all straight carpentry and there is no call for fancy kinks. Make the sides of 1½ in. (full thickness) yellow pine, using two pieces 10 in. wide and 24 ft. long, held together with 1 in. by 3 in. battens spaced 24 in. apart. The adjoining edges should first be beveled to leave a V-shaped space for the cotton caulking.

Cypress ⅞ in. thick by 8 in. wide is recommended for the bottom planking. Other material can be used, however. Bevel the edges slightly—about half the surface of the edge—to allow for the caulking. Lay a double fold of muslin soaked in white lead along the edges of the side pieces before nailing down the bottom boards. Draw the latter up tightly against each other with a wood clamp while nailing down.

Four stringers of full 2 in. by 3 in. yellow pine run lengthwise along the bottom of the scow, spaced as shown in the diagram, to support false bottom and engine bed. Install the latter and the paddle-wheel supports before starting work on the cabin framework. The distance between the engine-bed

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members will, of course, be determined by the type of engine used. The accompanying design is laid out for a Ford Model T motor, but can be adapted to other makes. See that the engine-bed is well anchored with lag screws, and this and the paddle-wheel supports securely bolted together.

The Cabin

CROSS pieces 2 in. by 3 in. are set at the front end of cabin and between cabin and engine room to brace the scow thoroughly. Full 2 in. by 2 in. studding, or uprights, if of good clear material are strong enough for cabin walls and to support the roof with the added weight of passengers. The studding is spaced 24 in. apart, and corners braced with diagonals, as shown in the sketch.

Allow for windows as per drawing, or any better arrangemen you may work out.

Supports for the side-decks are mortised into the side members and the inner ends secured to the cabin studs. These side-decks involve quite a bit of extra work but are useful in many ways, permitting access to canoe, rowboat or shore from any point of the boat.

Use ½ in. matched lumber for the siding, and ⅞ in. matched flooring on the roof. This is to be covered with canvas and painted.

The two forward windows are designed to swing in, with permanent screening on the outside. The same idea is carried out in the smaller windows above stove and sink, and in the toilet. Front door swings in, with screen door swinging to forward deck. At the back is a standard door but no screen is necessary, as sufficient ventilation is attained through windows and vent above stove.

Before laying the floor install toilet, sink, motor, pump and piping. Sink waste and soil pipe discharge from the stern, above the water line. A standard shore-type flush toilet can be used with the reservoir system carried out. However, a marine type toilet will simplify matters, especially if the sink is eliminated.

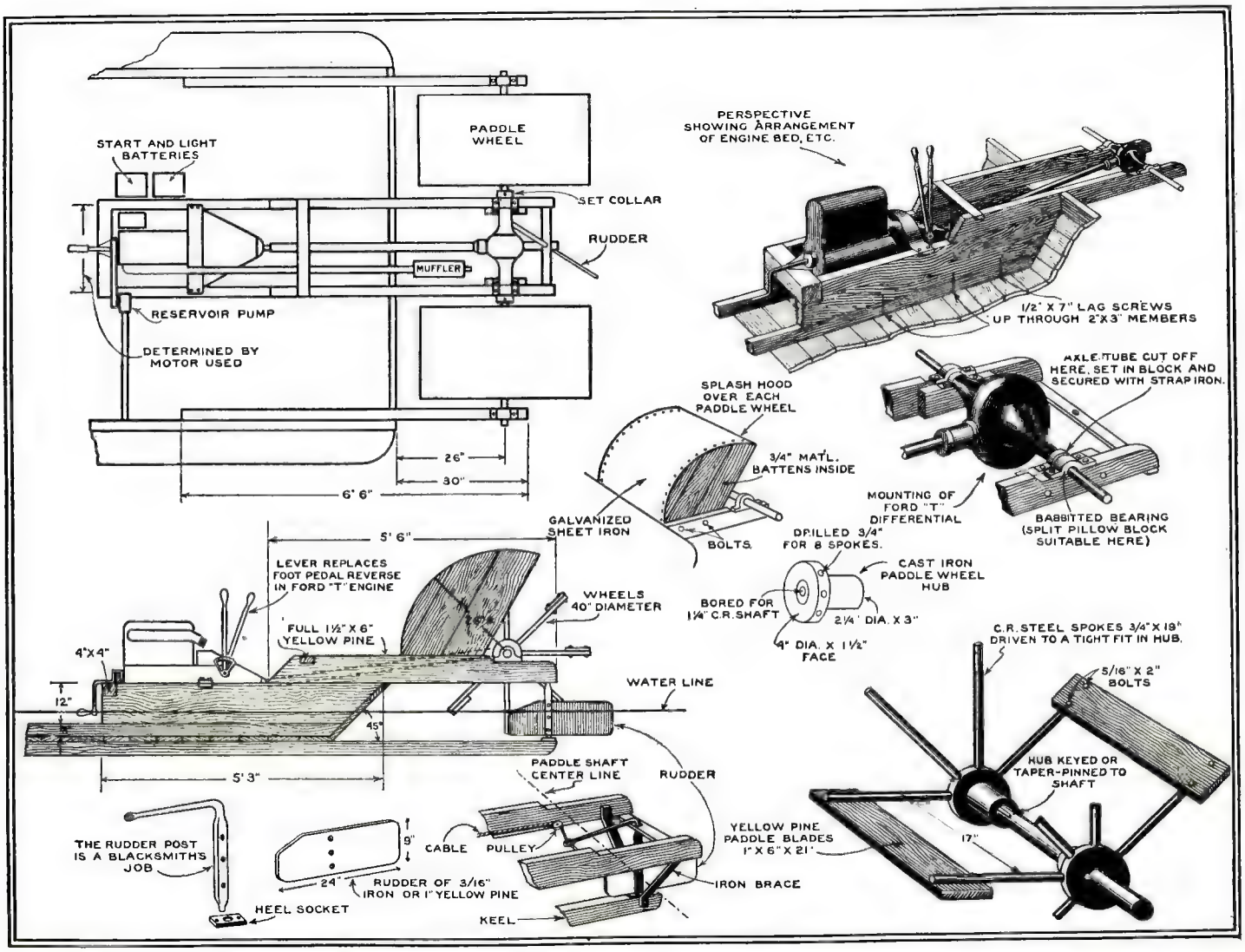
Pumping System

THE pumping diagram appears rather complicated and if the idea of all this work simply to have running water dismays you, leave it out and dip your washing water from the side. However, you'll have to install a pump for motor cooling if you use a pumpless Ford Model T motor. In the predecessor of this design we installed a complete water system, with bilge, sink tap and flush toilet. However, a marine motor was used with an integral pump, and a gear pump had to be added for the extra service. In any event your plumber will be almost indispensable and you will have the satisfaction of knowing the job is right. It's not an easy matter to tear down a piping system in a boat after it is launched.

Power Plant

FOR final drive the standard Ford Model T propeller shaft and differential is used, the axle tube being cut off about 7 in. from the center line of the differential housing. Ends of the tube thus amputated rest on wood blocks bolted to the two central paddle-wheel supports. A heavy strap-iron cap holds the tube end in place on the blocks.

Unless you can find something suitable at the junk yard for the paddle-wheel hubs and spokes it will be necessary to give



The power plant which uses a Ford model T engine is shown here. For final drive, the standard Ford propeller shaft and differential is used, the axle tube being cut off as illustrated.

A perspective showing the arrangement of the engine bed appears above. A lever replaces the foot pedal reverse. Yellow pine paddles are used and are bolted to the spokes.

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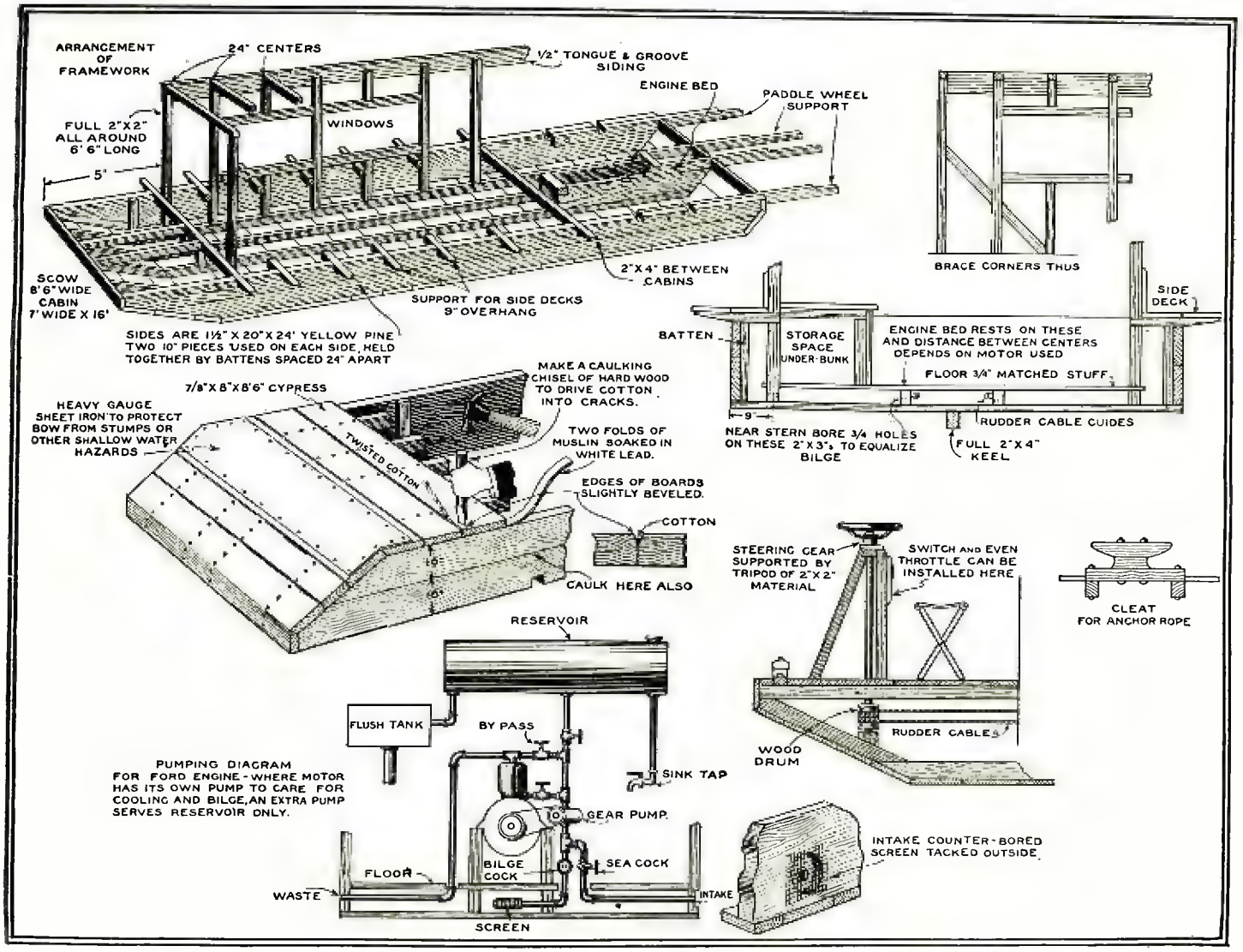
ARRANGEMENT OF FRAMEWORK
24" CENTERS
1/2" TONGUE & GROOVE SIDING
ENGINE BED
PADDLE WHEEL SUPPORT
FULL 2"X2" ALL AROUND 6' 6" LONG
WINDOWS
5'
SCOW 8'6" WIDE CABIN 7' WIDE X 16'
2"X4" BETWEEN CABINS
SUPPORT FOR SIDE DECKS 9" OVERHANG
SIDES ARE 1½" X 20"X 24' YELLOW PINE TWO 10" PIECES USED ON EACH SIDE, HELD TOGETHER BY BATTENS SPACED 24" APART
BRACE CORNERS THUS
SIDE DECK
BATTEN
STORAGE SPACE UNDER BUNK
ENGINE BED RESTS ON THESE AND DISTANCE BETWEEN CENTERS DEPENDS ON MOTOR USED
FLOOR 3/4" MATCHED STUFF
9
RUDDER CABLE GUIDES
NEAR STERN BORE 3/4 HOLES ON THESE 2"X3"s TO EQUALIZE BILGE
FULL 2"X4" KEEL
MAKE A CAULKING CHISEL OF HARD WOOD TO DRIVE COTTON INTO CRACKS.
7/8"X 8"X 8'6" CYPRESS
HEAVY GAUGE SHEET IRON TO PROTECT BOW FROM STUMPS OR OTHER SHALLOW WATER HAZARDS
TWISTED COTTON
TWO FOLDS OF MUSLIN SOAKED IN WHITE LEAD.
EDGES OF BOARDS SLIGHTLY BEVELED.
COTTON
CAULK HERE ALSO
STEERING GEAR SUPPORTED BY TRIPOD OF 2"X 2" MATERIAL
SWITCH AND EVEN THROTTLE CAN BE INSTALLED HERE
CLEAT FOR ANCHOR ROPE
RESERVOIR
FLUSH TANK
BY PASS
SINK TAP
RUDDER CABLES
WOOD DRUM
PUMPING DIAGRAM FOR FORD ENGINE - WHERE MOTOR HAS ITS OWN PUMP TO CARE FOR COOLING AND BILGE, AN EXTRA PUMP SERVES RESERVOIR ONLY.
GEAR PUMP
INTAKE COUNTER-BORED SCREEN TACKED OUTSIDE
FLOOR
BILGE COCK
SEA COCK
WASTE
INTAKE
SCREEN

The arrangement of the framework is illustrated above. The method of caulking is also shown.

The pumping system illustrated above provides for cooling the motor and also furnishes running water in the boat.

the job to a machinist. The design shown here has worked out very satisfactorily but involves some expense. The cast iron hubs are keyed or pinned to 1¼ in. cold-rolled steel shafts with inner ends milled to fit into the differential. Set collars hold them in position. Yellow pine paddles are bolted to the spokes.

Steering Gear

A TRIPOD of 2 in. by 2 in. material supports the steering gear—simply an automobile steering wheel on a vertical shaft, the lower end of which carries a drum about 3 in. diameter for the tiller cables under the forward deck. Screw eyes guide the cables along the two central 2 by 3's, and through pulleys to the tiller arm. Flexible steel cable is best for this purpose, but be sure it is properly installed before laying the floor. It would be well to have an inspection hatch in the floor of each cabin, in addition to that on the forward deck to make the cables accessible.

It will be necessary to call on the village smithy for the rudder post and iron braces each side of the rudder. The rudder itself can be made of 3/16 in. iron or ⅞ in. wood.

Interior Finish

IN fitting out the cabin you will have opportunity to exercise your artistic ability. For a summer home, either ashore or afloat, most vacationists prefer the unfinished wood interior. However, the use of light-weight wall board and mahogany stain will lend a more yachtlike atmosphere. Besides, double walls and an air-tight wood stove make for comfort if the houseboat is used for a shooting lodge during the duck season.

The two stationary bunks are designed for locker space underneath, and two extra berths are provided by the swinging cots made of canvas over a frame 20 in. wide by 6 ft. 6 in. long. These are supported by sash cord and when not in use are hooked to the ceiling out of the way. A folding, three-legged table is also a convenience, since it can be hung on the wall at the head of one of the bunks between meals and bridge games. Chintz curtains add greatly to the homey atmosphere. They are attached to the frames of the hinged as well as the other windows.

For illumination automobile spot lights are used, focussed on the ceiling for indirect lighting. A headlight on the roof is useful for night navigation and especially for catching bullheads. This is good after-dark sport in some lakes.

Navigation

IT is very likely that your family or guest list will include one other who is capable of steering or looking after the motor, and in this event controls at the steering wheel are unnecessary. But if you plan to navigate alone it will be no great trick to fit up switch and throttle on steering tripod on the forward deck. By this means you can navigate alone for all ordinary purposes, except when it becomes necessary to reverse.

In the drawing, Aunt Kate II may appear topheavy with the awning over the upper deck. This is merely an illusion. There is very little weight to the superstructure and with the low center of gravity four or six persons can move about at will up here without danger of disturbing the balance. It is a delightful place to spend a lazy summer afternoon.

The problem arises: "Where shall (*Continued on page* 183)

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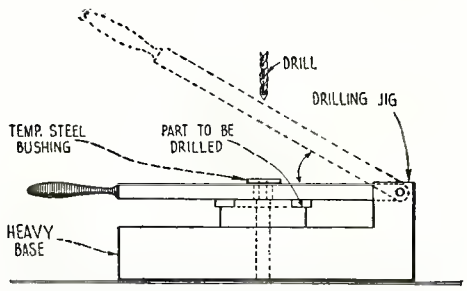
Shop Mechanics

This month we present a new department which will hereafter be known as shop mechanics. A ten dollar prize will be awarded monthly for the best shop wrinkle. Other ideas published will be paid for at regular rates.

The Editors will Welcome Contributions to This Department. Sketches Should Accompany All Manuscripts Whenever Possible.

If You Have Any Time and Labor Saving Kinks which Will Help the Mechanic, Submit Them to the Editor.

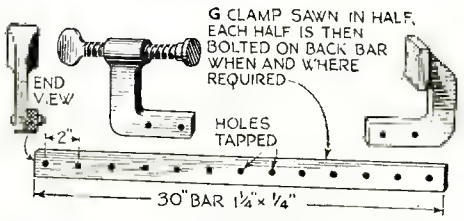
Drilling Jig



A jig such as that shown above will enable odd shaped objects to be drilled easily.

THE drilling jig illustrated consists of a heavy base with a wrought iron bar pivoted as shown. A tempered steel bushing is forced into a hole previously drilled in the rod or lever. The part to be drilled is held in place as shown, and the pieces of metal cut out by the drill fall through the hole in the base.—*H. W. S.*

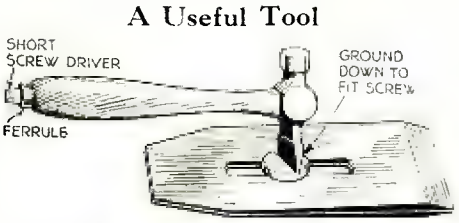
Clamp Bar



The clamp bar shown above was made from parts obtained from the scrap heap. The bar supported the window fixtures of a store.

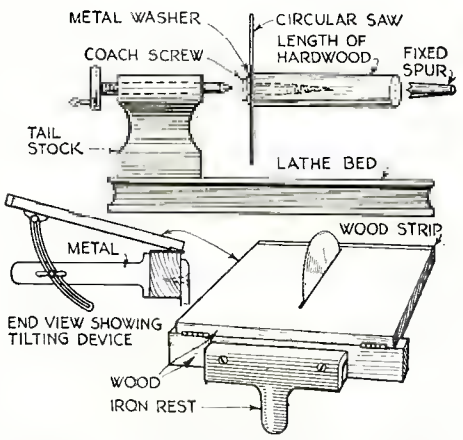
THE inventive craftsman will find useful pieces of metal in the scrap yard. The bar of the clamp shown is one which supported the window fixtures at one time. These bars vary in length and are usually tapped. The large G clamp was cut in the center and drilled and tapped to agree with the holes in the bar. The G clamp is fastened to the back bar with round-headed screws. The parts of the G clamp can be reversed on the back part and one can then exert a thrust when taking frame work apart.—*J. E. Lovett.*

A Useful Tool



A handy tool may be made by grinding down the peen of a hammer to make it fit the screw of the cap iron on a plane. A brass ferrule with a short screw driver blade is fitted on the edge of the hammer handle. When hanging a door this tool is especially useful as the screws can be tapped with the hammer head and the hammer reversed, in order to screw them in place, using one hand for the operation.—J. E. L.

Foot Lathe Saw
First Prize $10.00



A circular saw can be fitted to a foot lathe as shown above for cutting small grooves. A tilting saw table is also shown.

A SIX or seven inch circular saw can be attached to a foot lathe. The driving spur is a solid piece which extends through the headstock and is removable. A hole is bored in a length of hardwood and a coach screw carefully worked into it. The square head of the coach screw is slightly drilled and allows for the pointed end of the tailstock to engage the recess so formed. With the aid of a metal washer, this screw holds the saw to the hardwood. The right hand end of the wooden rod engages the prongs of the fixed driving spur, in the usual manner.—*J. E. Lovett.*

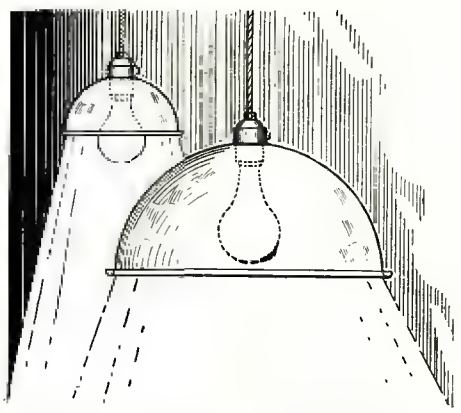
Brad Punch

The difficulty in punching oval brads can easily be overcome by making the incision shown. A "V" is cut in the end of the nail punch with a three cornered file. A 60 degree angle is the most suitable. This will eliminate all risk of the punch slipping.—J. L.

ANNOUNCING—

A new monthly department of interest to all mechanics. Shop workers, garage men, carpenters and electricians, will find here many short cuts and better methods for doing a particular task. It will be our endeavor to present articles of interest to workers in all fields. Contributions to this department should be in keeping with the nature of the ideas specified above.

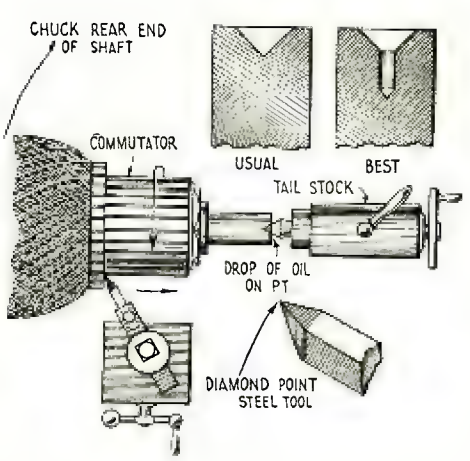
Reflectors



The above illustration shows two types of reflectors made from old auto reflectors.

EXCELLENT lamp reflectors can be made from old automobile reflectors very easily. For the garage or workshop these are ideal as the light is concentrated and cast fully upon the work. Different size reflectors are obtainable and their use will depend upon the individual requirements. The hole in the reflector may have to be enlarged to fit over the socket.—*Ray Balken.*

Tooling the Commutator



THE above illustration shows several kinks which can be used to advantage when machining a commutator. A diamond point steel tool is used and commutator rotated in the lathe in the direction shown by the arrow. The pointed end of the tailstock is engaged in a recess at the end of the motor shaft. The usual method of accomplishing this is illustrated, as well as a suggested better method. An oil channel is provided at the end of the recess. With this arrangement, the work does not have to be interrupted for oiling as frequently as with the usual method.—*H. W. S.*

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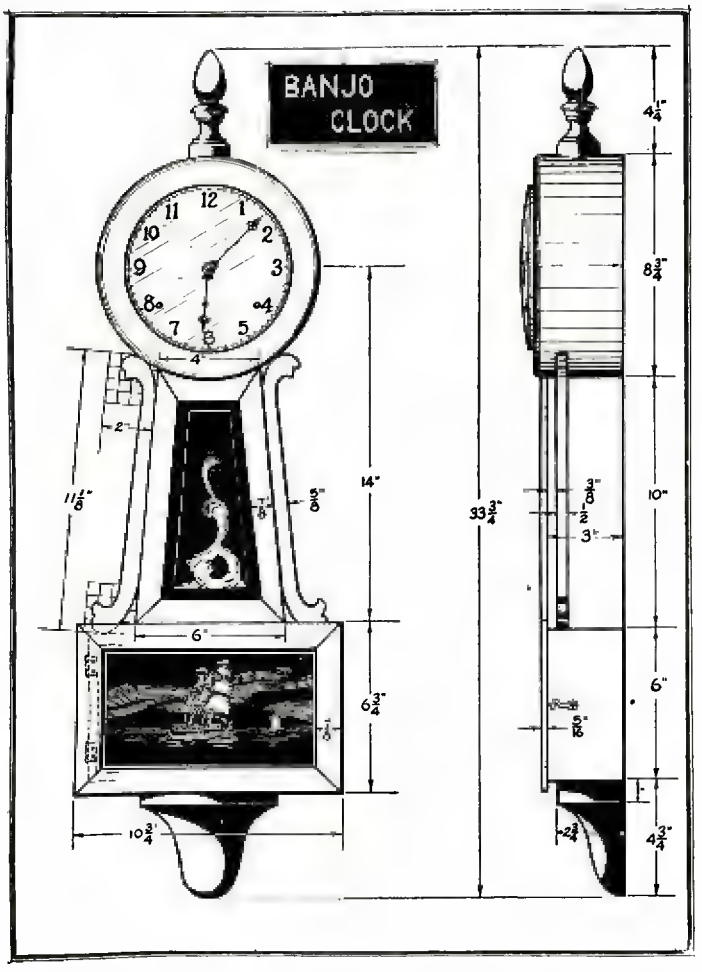
How to Make a Banjo Clock

WOOD TURNING

By H. L. WEATHERBY

Article Number Eleven In a Series

Since the earliest American times, banjo clocks have always been popular, and in recent years these clocks have virtually flooded the market. Many were cheap imitations, unlike the graceful timepiece described in this article.



The construction which is shown in the drawing will not prove difficult, as all details are given. The case is of mahogany.

An Artistic and Reliable Clock in Banjo Style is Not Difficult to Construct if Directions Are Followed.

The photographs appearing here show a front and a rear view of the finished banjo clock.

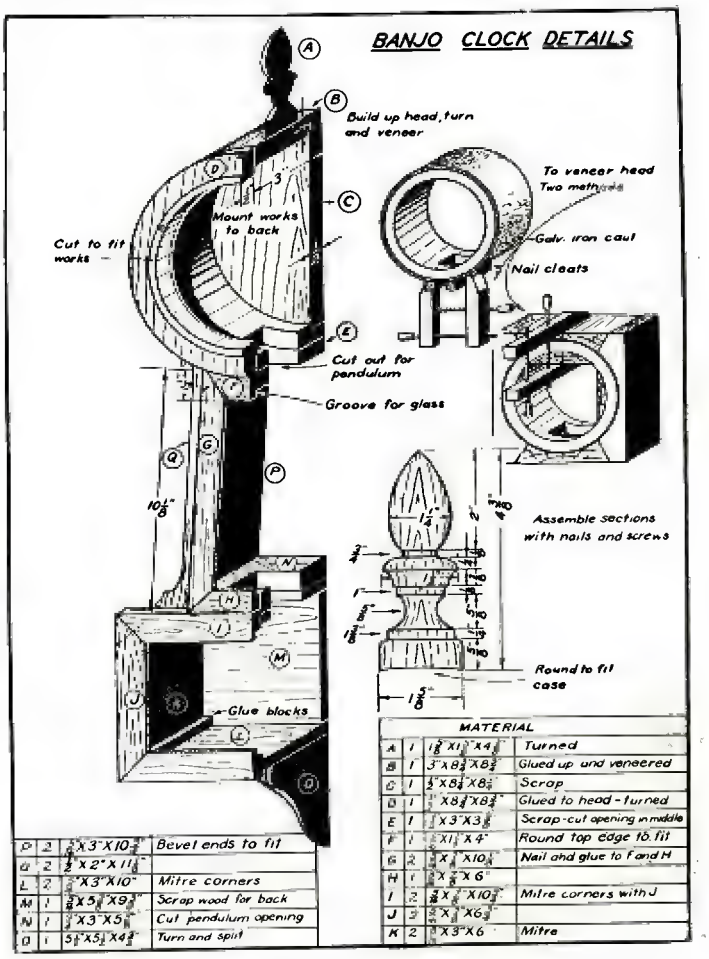
BANJO clocks have been popular down through the years, from early American times to the present, and in recent years their popularity has increased to such an extent that floods of cheap imitations have made their way into our department stores and novelty shops. This popularity of the genuine banjo clock is not without good cause. They combine, when equipped with reliable works, a beautiful and graceful exterior with a good timepiece. The glass front door in the bottom is usually decorated with a marine scene, while the glass panel above is decorated with scrolls in gold leaf or bright colors.

Veneering the Head

THE construction, which is shown clearly in the drawings, will not prove difficult with the possible exception of the veneering of the head of the clock. This calls for rather careful work, but the finished job will not be a satisfactory one if the head is not veneered.

The material for the case should be mahogany or a good substitute. The head may be made up of any hard wood, and should be glued up, rather than trying to get a solid block of sufficient size.

This block should be cut to octagon form before turning, to cut down lathe vibration. After the outside is turned to dimension, the inside of the head is bored out, using heavy tools for this purpose. It will quite likely be necessary to cut from one side part way, and chuck for the remainder in removing the inside from this piece. (*Continued on page* 182)


BANJO CLOCK DETAILS
Build up head, turn and veneer
Mount works to back
Cut to fit works
Cut out for pendulum
Groove for glass
To veneer head
Two methods
Galv. iron caul
Nail cleats
Assemble sections with nails and screws
Round to fit case
Glue blocks
10⅛"
1¾"
1⅝"
MATERIAL
A 1 1⅝" X 11" X 4½" Turned
B 1 3" X 8½" X 8½" Glued up and veneered
C 1 ½" X 8½" X 8½" Scrap
D 1 ⅞" X 8½" X 8½" Glued to head - turned
E 1 ⅞" X 3" X 3⅛" Scrap - cut opening in middle
F 1 ⅞" X 11" X 4" Round top edge to fit
G 2 ⅞" X 1" X 10⅛" Nail and glue to F and H
H 1 ⅞" X 5⅛" X 6" Nail and glue to F
I 2 ⅞" X 1⅛" X 10⅛" Miter corners with J
J 3 ⅞" X 1⅛" X 6⅛"
K 2 ⅞" X 3" X 6" Miter
O 2 ⅞" X 3" X 10⅛" Bevel ends to fit
Q 2 ½" X 2" X 11⅛"
L 2 ⅞" X 3" X 10" Miter corners
M 1 ⅞" X 5⅛" X 9⅛" Scrap wood for back
N 1 ⅞" X 3" X 5⅛" Cut pendulum opening
P 1 5⅛" X 5½" X 4¾" Turn and split

Complete working data for the construction will be found in the above drawing. The head of the clock is covered with mahogany veneer about one-thirtieth of an inch thick.

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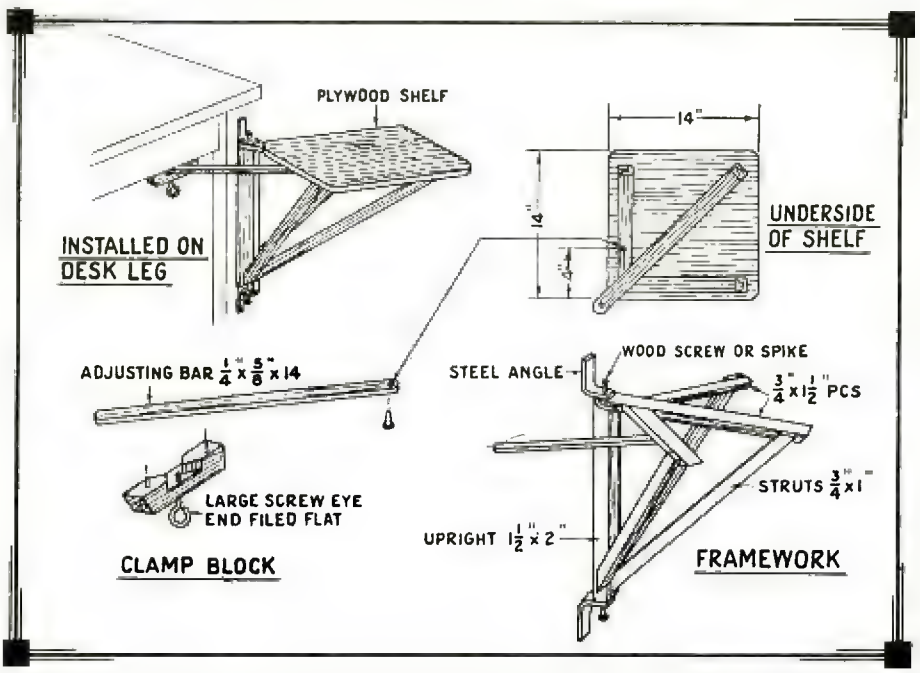
How To Make It

Swinging Typewriter Stand

FOR those who do even a small amount of typewriting, a swinging stand will be found a great convenience. The cost is negligible and the stand can be completed in a short time. Plywood makes a good top because of its lightness and pleasing grain. It is amply strong for the purpose. In cutting, a fine toothed saw should be used, so that the material is not torn and the edges can be smoothed with a file or course sandpaper.

The top is supported by three battens made of ¾"x 1½" stock or any other suitable size which the constructor may have on hand. The battens are supported by struts attached at the bottom to the heavy upright post or "backbone." Small angle irons can be purchased at either hardware or 5c and 10c stores for about ten cents a pair, including screws.

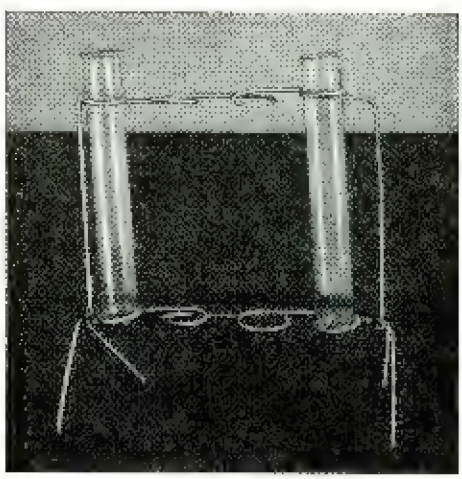


The above illustration shows the various details in the construction of the swinging typewriter stand. A plywood shelf is supported by three battens.

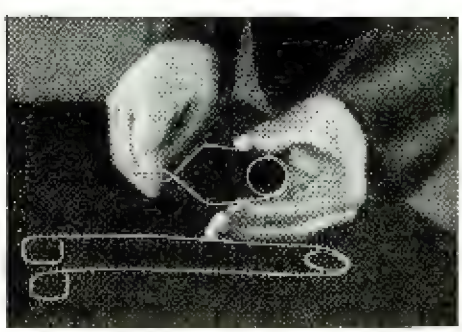
The clamp consists simply of a wood tie-bar or clamp-bar attached to the underside of one of the battens. This slides through a notched block screwed to the under edge of the table as shown. A large screw-eye with the point filed flat, serves as the thumb screw for clamping in any position. The completed stand should be stained to match the desk. The convenience of such a support is surprising.—*Hi Sibley.*

Equipment for the Home Laboratory

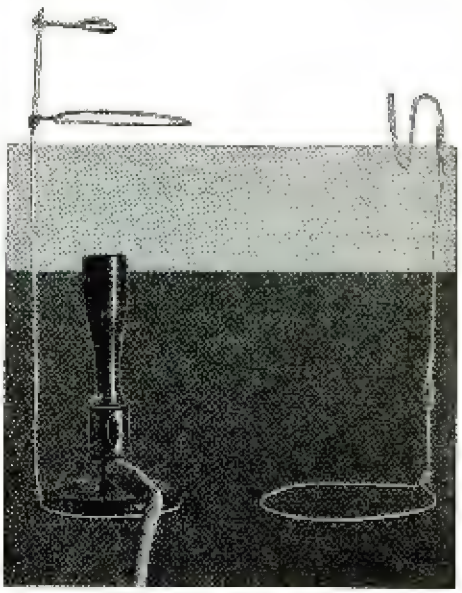
AMATEUR chemists who wish a well-equipped laboratory at small expense can profit from the experience of one who has equipped his entire laboratory with mechanical appurtenances at a cost of about twenty-five cents. An example is a holder for test tubes made of No. 14 galvanized wire. Holders for flasks and bottles can be constructed in the same manner. One or two can be made without feet for fastening to the wall. A test tube clamp is easily made from wire, as well as other useful clamps for holding small objects when fusing over the bunsen burner. It is also necessary to have a support for holding a dish or pan above the burner. Different size loops are made to be instantly adjustable to the upright. A hoop support is also shown and is made from two pieces of wire so as to be adjustable. An instrument for removing corks that have been pushed into bottles is also made from wire and has three claw-like ends. Supports for evaporating dishes are easily made. A wire frame covered with wire mesh can be made and used to shield the eyes while experimenting with chemicals which may explode. Many other devices will suggest themselves to the amateur chemist.—*Ken Murray.*



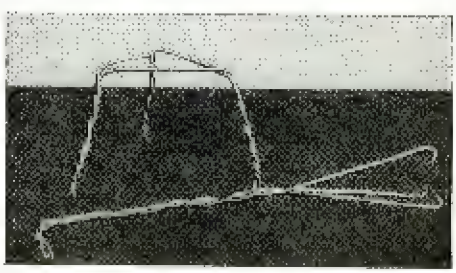
A test tube holder made of No. 14 galvanized wire is shown in the above photograph. A pair of pliers are all that is necessary in making the holder. One can be made for any number of test tubes with the addition of more wire loops.



Two clamps, one for test tubes, and the other, for holding small objects.



Laboratory dishes are easily supported on the above adjustable ring stand.



A cork remover and a wire support for holding evaporating dishes are shown above.

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READERS FORUM—

SCIENCE AND INVENTION desires to hear from its readers. It solicits comments of general scientific interest, and will appreciate opinions on science subjects. The arguments pro and con will be aired on this page. This magazine also relishes criticisms, and will present them, whether caustic or not. So if you have anything to say, this is the place to say it. Please limit your letters to 200 words or less, and address your letters to Editor—The Readers Forum, c/o Science and Invention Magazine, 230 Fifth Avenue, New York City.

Questions Telepathy Prize

Editor, SCIENCE AND INVENTION:

I wonder just how sincere is your offer of $5,000.00 for proof of telepathy, as stated in your last issue. And what conditions would you require for the test?

That may sound insulting to you, but then the whole tone of your reply to one of your readers as to her experiences, in which you made mention of your offer, was that of prejudgment, of having already arrived at a definite opinion on the subject; hardly a neutral frame of mind which, it seems to me, should approach a question for such scientific investigation. Nor, in the light of the many things that have been learned and which have been done in the past twenty-five years, does it seem to me to be wise to say a thing is impossible.

Merely because you have not had such experiences, or have known of many charlatans, is not a valid reason for positive denial.

I have had dozens of experiences which I have checked carefully to eliminate the question of coincidence. Many times I did not want to believe, sought to lay them to other causes, organic or my own subconsciousness. But I have been forced to believe the cause to be telepathic.

From my personal experiences, it is my judgment that many of the experiments, as heralded in the press, have been so extremely unscientific as to be ridiculous. I have in mind the attempt to cross the Atlantic. Neither with the telegraph or radio did they attempt anything like that at first. They did not seem to consider that there could be poor and good conditions, that a technique might be necessary. They did not seem to know or realize, for instance, that an emotional element back of a thought or idea to be transmitted produced a stronger "mental wave" than a straight mental picture or thought without it. Nor that one person may be a stronger transmitter than another, or that the one receiving may, in the language of radio, be only a one-tube set, not one with eight tubes. Nor, to continue the analogy, that the receiver has to be "tuned in" with the transmitter. In other words, there must be a bond of mental and emotional sympathy between the two to get positive and best results.

Prepare the foundations for these three best conditions, a strong transmitter, a sensitive receiver, a bond of personal sympathy, and you can get your positive proof. There is nothing wrong in making tests under the most favorable conditions. Get your proof first, test your materials and working conditions, learn something of the laws governing it, seek to learn the best technique. Let the crossing of the Atlantic and tests over the radio wait. My own experiences, for instance, have not been farther than five hundred miles at the most.

Just one thought: there are many people, more than you think, Mr. Editor, who have telepathic experiences. But they do not mention them often, not caring to be the subjects of ridicule. The attitude of most people, those who have not had such experiences, is too much like your reply to your young lady reader. Her experience is perfectly possible. Hate—and love—are the two emotions most easily transmitted and received. I have had similar experiences. I have been engrossed in a game, for instance, and feeling the sensation come which I had learned to recognize, have turned around to find that a man who hated me had just come into the room. And she is correct in stating that it does weaken and drain one's strength.

This law, like Nature's other laws, can be used for good or evil. And it is because of this that experiments should best be done under scientific control. Too much harm can come to people experimenting with it. I say this because of my own experiences.

Approach this subject in a neutral frame of mind, Mr. Editor, without bias or set opinion, and eventually you will get your positive proof.

MR. X,
New York City.

(The mere fact that we have been unable to witness any genuine demonstrations of telepathy in the past six years (ever since this prize award was originally published), and the fact that all about us people are supposedly demonstrating telepathy, but when they are investigated privately or from a magazine standpoint, prove to be demonstrating the very simplest forms of trickery, might not necessarily imply that such things as telepathy do not exist, but our investigations certainly cast grave doubts on the possibility of genuine telepathy. No demonstration has ever indicated that there are such things as mental or thought waves. No investigation with even the finest laboratory apparatus has proven the existence of these thought waves. With the exception of a few inmates in asylums who profess to be under the guidance of some master-mind, we have no stronger proof than hearsay evidence; nothing to which the scientific yard-stick can be applied. But you ask us to prepare the foundation for the proper conditions for thought transference. We make no conditions; we permit both transmitter and receiver to engage in the demonstration. In order to be sure that thought is being transmitted, we dictate the thought to be transmitted. In so far as distance is concerned, we permit both transmitter and receiver to be back to back. Need anything be more fair?

But, must this subject be viewed in a neutral frame of mind? Does a person also have to believe in telepathy before it can be demonstrated, the same as an individual must believe in spiritualism before evidences of that subject can be given? Do you find it necessary to believe in aviation before you can witness an airplane flight, and believe in the incandescence of a filament, when current passes through it, before you can see a demonstration of the light from a lamp bulb? Can't a non-believer in aviation see a plane in flight, and be convinced? The idea of neutrality is too ludicrous to hold. If these phenomena exist, they can be proven to even the skeptical. Why, then, are they not so proven? While it is true that we have made the statement repeatedly that thought transference does not take place, and this statement was borne out by years of scientific research work, and by years of our own investigations, both private and public, we are ready to retract all statements that we have made with reference to this subject if we are convinced of our error. Our willingness and earnestness is exemplified by our posting a $5,000.00 award for such a demonstration.

*We are desirous of putting a scientific yard-stick upon thought transference to determine, if possible, what this power may be, and to develop it so that if it exists, it can be put to more useful scientific purposes. Before anything further can be done, the existence of the effect must be demonstrated. One cannot utilize the power of steam before one knows that such power exists. One cannot utilize the power of thought transmission before one knows whether that exists.—*EDITOR.)

IN THE JUNE "AMAZING STORIES"

RADIO TELESCOPE, by Stanton A. Coblentz. Television seems to have been taken off the board, for a while, but there is no question as to the possibilities of radio and television in the future. With characteristic imaginative foresight, the author of "The Sunken World" gives us, in concentrated form, an extremely well written story full of plausible science.

THE MONGOLIANS' RAY, by Volney G. Mathison. Here is a capital scientifiction story, that would have done O. Henry honor for its rare surprise ending. It contains good science, excellent fiction, suspense and adventure and makes thoroughly interesting reading.

FINGERS OF THE MIST, by Peter Brough. Synthetic life is no novelty in the laboratory. Scientists claim to have come pretty close to the secret of life, although only microscopic living beings seem thus far to have been produced. Dr. Loeb, one of the pioneers in this field, has accomplished a good deal in his experiments with synthetic life. This story, based on accepted scientific theories, is excellently written and is of absorbing interest, and contains much food for thought.

THE ENGLISH AT THE NORTH POLE, by Jules Verne. (A Serial in Two Parts.) Part II. Though the story thus far was unusually well written, even for the father of scientifiction, it traveled over more or less familiar territory. Now that the expeditionists have reached 78° N.L., the excitement and adventure start and we learn a great deal about the territory in the neighborhood of the North Pole—much of it proven fact. Both the story and scientific interests are fully sustained in the concluding chapters of this story.

And in honor of Sir Wilkins' contemplated trip to the North Pole in a submarine, we are incuding in this issue's instalment, one-half of the sequel to "The English at the North Pole," which shows these English forging further and further north, almost in direct line with Sir Wilkins' plans.

Houdini's Investigator

Editor, SCIENCE AND INVENTION:

I am very much interested in the expose on Spiritualism by Houdini's investigator appearing in the *New York Journal.*

What is your opinion as to the authenticity of these articles, or do you consider it newspaper propaganda?

ETHEL LOCKWOOD,
New York City.

(The series of articles prepared by Miss Rose Mackenberg, and copyrighted by the King Feature Syndicate, now appearing in the Hearst publications throughout the country are absolutely authentic. This writer personally knows Miss Mackenberg, and has had access to her files. If anyone cares to look up the congressional records, they will find that Miss Mackenberg presented testimony on Mr. Houdini's behalf before the Senate.

Miss Mackenberg generally preceded Mr. Houdini by one or two weeks, and left information for him about the most prominent mediums

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THE EDITOR'S MAILBAG

in the town. These she investigated personally, and always left some mark somewhere in the room, indicating that she had actually visited the medium's place. Sometimes a notation was left in the family Bible. At other times, a mark was put in back of a picture, under the table, under a chair, or elsewhere. When the medium came to the theatre, after being openly challenged by Houdini, Houdini would accuse the medium of nefarious practices, and if a dispute arose, he would request that the medium remain while an impartial committee went to the medium's house to find the mark left by Houdini's investigator.

These articles further prove our viewpoints on the subject of spiritualism. They will do harm to fraudulent spiritualism, and much good to the public. We congratulate the Hearst papers on being able to acquire these facts and giving them the prominence this subject so richly deserves.—EDITOR.)

Increasing Height

Editor, SCIENCE AND INVENTION:

I am enclosing herewith a clipping from the *San Francisco Examiner,* regarding the Glover Institute. The proprietors, Louise Glover and Bernhard Bernard, who originated the body stretching apparatus for increasing one's height, have been doing a successful mail order business, since 1927, I believe. It was reported in another paper that the net profits for one year amounted to something like $10,000.00, which is not so bad. It also shows how easy it is to fool people. L. C. Glover and her partner started their business in Sausalito, a small town just a short distance from San Francisco, but they moved their office to Chicago, as you will see from the attached advertisement in the ———— magazine, a leading publication.

I am glad to know that the Postal authorities investigated and gave the Glover Institute the deserved finishing touch.

Trusting that this letter will interest you, and with kind regards, I am

G. G. KRAUSE.
San Francisco, Cal.

"Height Increasing"
Is Report of Hundreds
Results have been remarkable. Letters from all over tell of decided height increase gained in a few months. They tell of improved health, more pep and life, greater efficiency, more joy in living because of better physical condition. Nothing like our course. Based on sound, proven, scientific principles.
No Drugs—No Dope
We have no magic medicine to sell Only a system of simple exercises and special diet, assisted by a simple apparatus. Takes but a few minutes each day. The Glover system helps overcome the flattening of the vertebrae and the sagging of the supporting muscles. Permits cartilage cushions in spinal column to expand. Strengthens muscles. Stimulates nerves. Results have been permanent because based on true physiology. Unusually successful in under-developed young men and women.
EASY—INEXPENSIVE—CERTAIN
Write today for FREE Information
GLOVER INSTITUTE — Dept A17
508 S. Dearborn St. Chicago, Illinois

Some magazines are not adverse to accepting advertisements from organizations doing questionable business. Other publications are quite particular, but often do not know that the advertisers of goods are not thoroughly responsible, and that the claims made for their products are based on fraudulent premises. One must not jump to the conclusion that a magazine in which an advertisement appears not backed by a reputable organization, always caters to this class of trade. For example, the advertisement at the left of a stretching machine was clipped from one of our most respected publications. The clipping at the right from the San Francisco Examiner *tells us what happened.*

Alluring Literature Used by Bernard to Promote Sale of Novel Neck Stretching Machine
Methods of the "Glover Institute of Stature Building" were revealed yesterday when apparatus designs to increase one's height by inches was brought over from Sausalito by postal inspectors who arrested Clara Louise Glover and Bernard Bernard on charges of using the mails to defraud.
The device consists of ropes and handles, with a strap to go under the chin and back of the neck. The idea is, according to literature held by Assistant U. S. District Attorney Joseph Sweeney, to counteract the force of gravity by allowing the body to stretch.
"ADVANTAGES" CITED.
In one booklet, entitled "Stature Building," advantages of the system, which includes diet, are set forth in great length.
"The body is capable of shortening and lengthening," reads one caption, while another deals with the elasticity of bones, and the manner in which the force of gravity retards height.
In this booklet are included a number of illustrations, showing the great prestige enjoyed by the tall man in business, sports, society, and even in defending himself against a hold-up!
According to information

(We thank you very much for your comments concerning the body stretching machine, and we have purposely deleted the name of the magazine from which this advertisement was clipped. We do not think that the publication to which you refer knew that the organization was operating fraudulently; otherwise the advertisement would never have appeared. In order not to cast any reflections upon them, we have taken this particular stand. Nevertheless, the advertisement is duplicated herewith for the benefit of our readers. The clipping and advertisement appear on this page.—EDITOR.)

Voice-Operated Typewriter

Editor, SCIENCE AND INVENTION:

I noticed in your February issue a picture of a man speaking and a typewriter printing his words. I took particular notice of it because several months ago I conceived the idea that it was possible. I set about in my slow way to work out such a machine. I did not have the money to work with, so I made only simple experiments. I supposed I had the field to myself, and had all the time I needed to work it out. I had my work completed, but for two or three minor points, when I saw that picture. I then realized that not I alone, but the whole world was interested, and that sometime soon someone will make such an invention. I got down to work in earnest. I cleared up these points which troubled me. Then I invested the rest of my money in apparatus and materials and went to work to check up point by point the theories I had drawn. However, my small supply of funds didn't take me far enough. I had to accept as checked every part that is working in some device today. It is not unreasonable to expect them to work for me as they work elsewhere. And so I can say I have found a way to print spoken words on the typewriter. Of course, I have not yet got a working model together, and I'm stuck there because of a lack of funds.

BOB BURRILL,
Pasco, Wash.

(The idea of a voice-operated typewriter is not at all new. Many years ago this machine was not only conceived, but actually built. The difficulty with such typewriters is that the strings operating the keys respond differently to different voices. Most of these typewriters have vibrating strings or vibrating reeds, which are set in motion by the voice. When the string vibrates or the reed vibrates, it closes an electrical circuit, actuates a solenoid, and the plunger pulls the key down, striking a letter in the usual fashion. But the frequencies of response are different. A woman talking to such a typewriter would set a different set of strings in motion than if a man spoke, and the same is true of differences in the tonal quality of the voice. Then again, there are very few of us who haven't some impediment of speech which would be brought out by the typewriter.

If we assume that such mechanisms can be made absolutely perfect, we would have to have a new language so that what is written by the typewriter could be understood or else some form of interpretation would have to be made. Such a typewriter would be entirely phonetic, and it would mean as much to the average individual as shorthand notes mean to the average person. Who could understand the word "physics" spelled out on such a phonetic typewriter as "fizix." Who would understand that we mean "boys" when the machine produced "boiz," or if the word "arcade" were given to us as "rkaid"?

A voice-operated typewriter would be of scientific interest. It might be used to correct impediments of speech. Nevertheless, its advantages are questionable.—EDITOR.)

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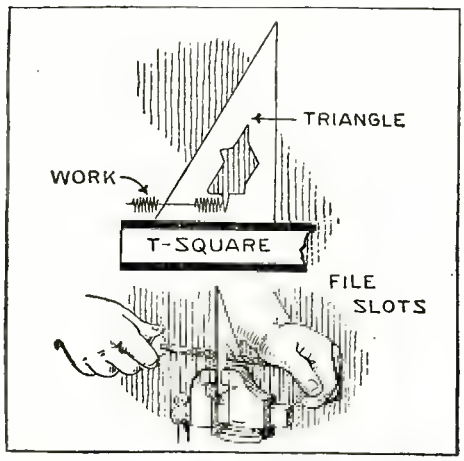
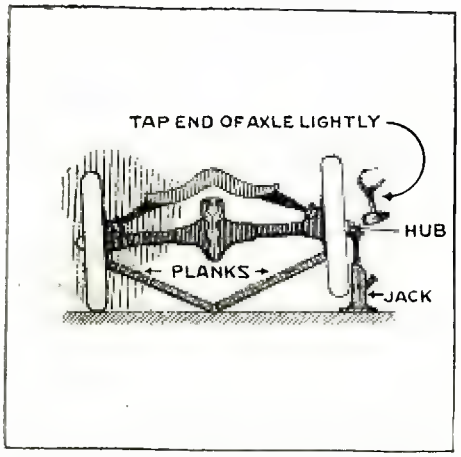
WRINKLES, RECIPES *and* FORMULAS

Drafting Aid



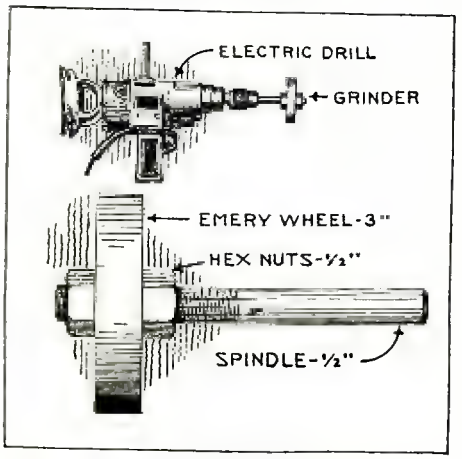
Draftsmen who make electrical drawings and have to make a number of resistance symbols, will find that if slots are cut in a triangle as shown, the task becomes simply one of working between two guide lines. —B. F. Hoops.

Removing Tight Wheel



To remove a tight rear wheel, the hub cap and nut are removed and wheel jacked up. Two planks are cut to fit against the wheel as shown. The jack is then let down and axle tapped at same time.—J. C. Wilson.

Substitute Grinder

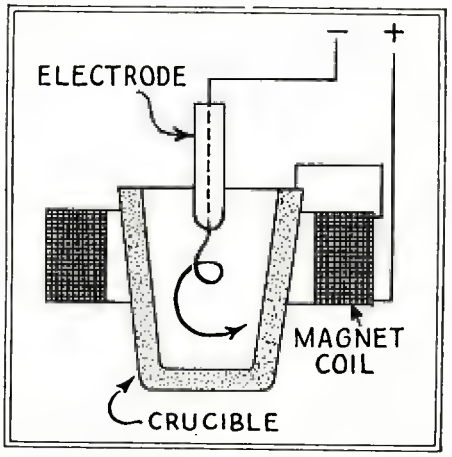


A small emery wheel fitted with a spindle as illustrated can be held in the chuck of an electric drill, and forms an excellent wheel for grinding small objects.— W. A. Bjorklund.

New Electric Furnace With a Revolving Arc

In former electric arc furnaces the arc is short and its heat radiation slight. Accordingly, the endeavor is made to lengthen the arc. The advantage appears principally in reducing the time required for fusion. The means to attain this result have been to increase the difference of potential in the arc. But there is naturally a limit to this potential on account of the uncertainty of operation. As the arc could not be lengthened by simple separation of the carbons, the observation was utilized that the arc can be affected in its path by magnetism. This can be done by induction coils, magnets, and the like, and the Russian inventors, Evreinoff and Tilney have had success with this feature. Their first furnace had a capacity of 125 kilograms, was put in service in 1923, and has to its credit 4,000 fusions. In 1926 they built two other furnaces, one of 225 and one of 325 kilograms capacity for a direct current and 300 volts potential.

The arc passes from a straight electrode to a ring electrode taking a spiral path under the action of a vertical magnet field which is produced by a coil connected in series with the arc. As long as the furnace is cold, when the current is first turned on, the arc is intermittent, but as the temperature rises, it becomes more constant and quiet, and is perfectly even when the substance to be treated has melted. Then the furnace is opened and the melt is refined. In construction the new furnace is the same as the preceding ones except that below in a sheet iron case, on the inner side, the exciting coil of waterproof insulated copper wire is placed. No larger furnaces on these lines have yet been built, but this revolving arc furnace will undoubtedly be employed eventually in steel works.—*Peter Bünge in Frankfurter Zeitung.*

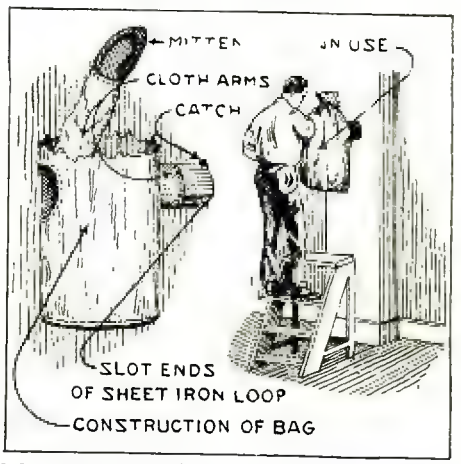


The above illustration shows the principles of the electric furnace. The arc takes a spiral path under the action of a vertical magnetic field.

Protection from Noises

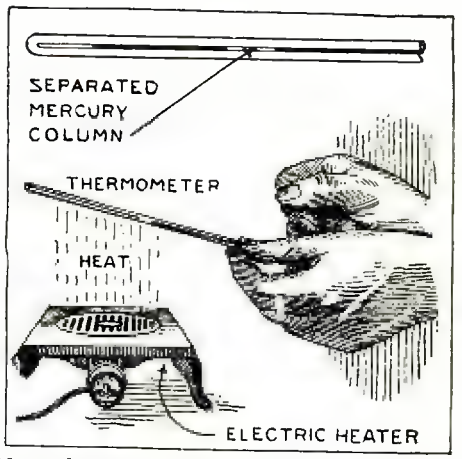
Convalescents or nervous people who are bothered by noise, such as that due to passing traffic, street-car bells, etc., will find comfort by purchasing a pair of rubber ear-stoppers, frequently used for swimming. They come in small, medium and men's sizes, and while I don't believe it is good to rely on them for too long a time, I have a friend who depends a great deal on them for relief from distracting noises.—*Contributed by E. L. Dunbar.*

Soot Remover



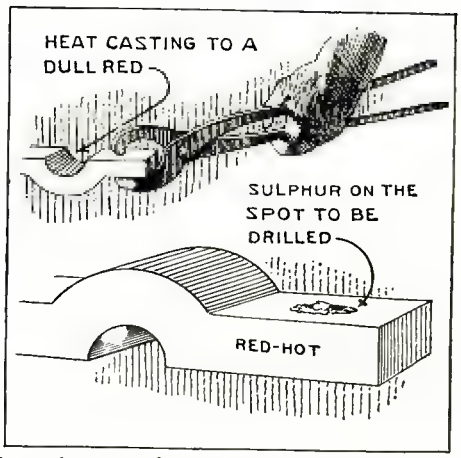
The soot removing device is illustrated above. The sack is constructed of burlap or duck and an arm and a leather or cotton mitten are sewed together. A small arm is also fired in the sack and fitted with an iron ring which is forced into the chimney. —Esten Moen.

Thermometer Repair



Many thermometers are thrown away because the liquid column becomes separated. They can be rendered serviceable by heating until the top section of the liquid column reaches the end of the tube. Then heat until remainder of liquid closes gap.—R. R. Le Compte.

Drilling Hard Iron



In order to soften a piece of iron which is too hard for the drill, heat locally to redness and place a small piece of sulphur on the spot to be drilled. This softens the iron during the cooling process.—J. M. Wolfskill.

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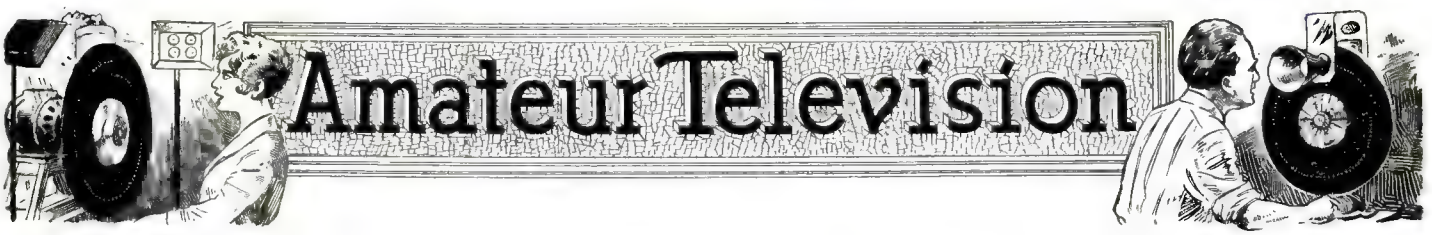

Latest Radiovision News

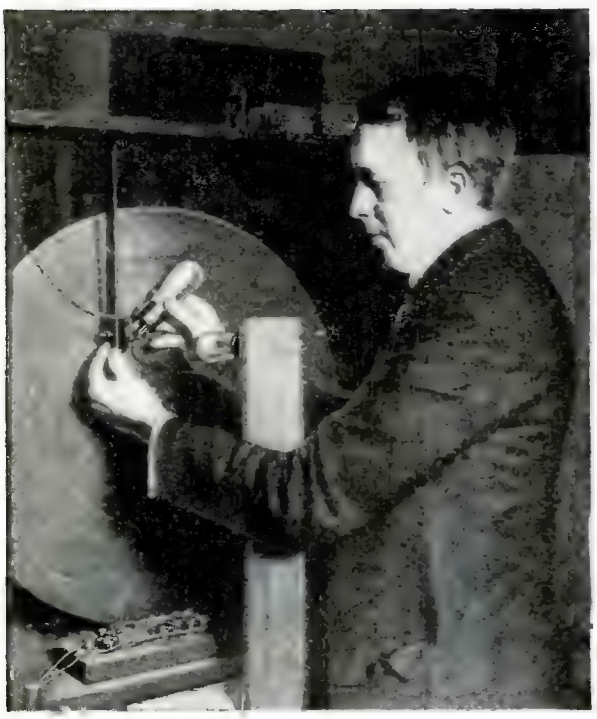

Fig. 1—The photograph at the right shows Denez von Mihaly with his recently invented television receiving apparatus. Note lens for enlarging image.

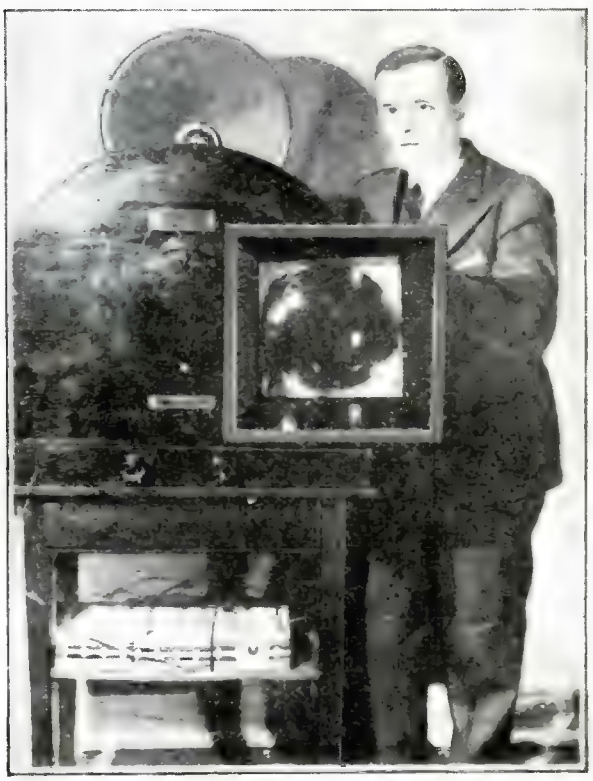

Fig. 2—At the left is a photograph of a new neon tube of the crater type to be used in television receivers. The inventor is shown placing the tube in position.

TELEVISION, the recent outgrowth of radio art, is steadily being improved and tireless inventors throughout the world are striving to bring it out of what may be termed the infant stage, so that its possibilities, both commercial and entertaining, may be realized.

Fig. 1 shows a photograph of Denez von Mihaly, a Hungarian inventor living in Berlin, who has recently perfected apparatus which permits the transmission of moving pictures by wire or by radio. The main receiver of the apparatus is shown in the photograph with the scanning disc clearly visible and control knob and switch mounted directly below. The image is enlarged by a sizable lens, yet good detail is maintained. The lens is mounted in a mask box on one side.

Fig. 2 shows a western inventor with his newly invented neon lamp which is similar to the Moore crater lamp. It is used in conjunction with a disc containing a number of small holes, contrary to the Alexanderson method, which employs with a similar tube, a disc having a spiral of lenses. This permits a large picture to be thrown on a screen, so that it can be comfortably viewed by a number of people.

The Jenkins system of television permits the broadcasting of silhouette images only. At the present time, 2,304 small, light sensitive cells are used at the transmitter. These are mounted, row upon row, on a board or grid and are connected by an equal number of wires. Fig. 3 shows the maze of connecting wires and the commutator which successively connects each cell in the circuit. At the receiver, 2,304 tungsten grid lamps are used. These are mounted in a holder and a segmented commutator is also employed which runs in synchronism with the transmitting commutator. Each one of the cells represents one two-thousand three-hundred and fourth part of the so-termed elementary area. Between the transmitter and receiver, approximately twelve stages of vacuum tube amplification are used. The slight lag in the extinguishing of the small tungsten lamps smoothes out the received picture. The system was designed primarily for use in theatres and public halls. According to an announcement recently made by James W. Garside, of the Jenkins Television Corp., it is expected that television broadcasts of sporting events will soon be made. By using specially prepared films, radio movies can be transmitted.

Fig. 3—The above photograph shows the complicated wiring of the transmitting board used by C. Francis Jenkins.

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Radio Cabinet Design Enters New Phase

A Radio Color Screen

The Latest Development in Radio Cabinets is the Provision of Music With Color. Directions for Making Your Own Color Cabinet Are Given

Above is a photograph of a manufactured receiver equipped with a color curtain. Fixed colors, as well as changing colors, produce effective results.

Radio Department

CHANGING color effects have recently been added to the radio receiver. It is now possible to have an accompaniment of color to music in your own home, merely by turning on a switch. The construction of the color device either of the fixed or changing type is not difficult, and full directions are presented.

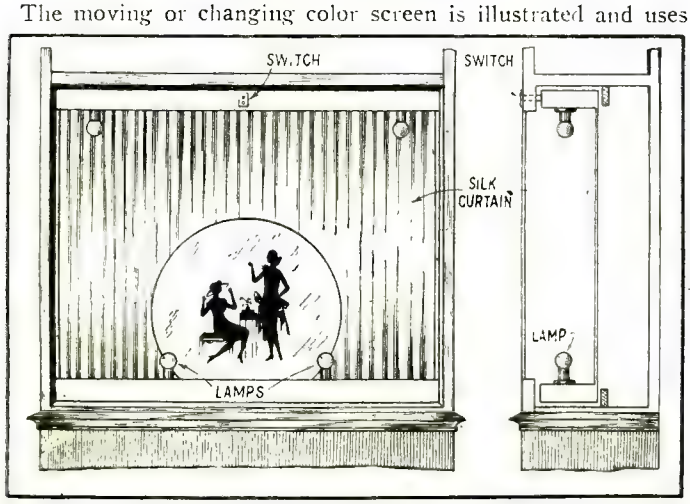
FOR a long time color has been associated with music and in the theatre this was first used to good advantage. Musical offerings are made more beautiful because of the accompanying changing lights and colors. It is now possible to have this effect right in your own home through a development recently announced by the Edison Lamp Works of the General Electric Co., at Harrison, N. J. A photograph of one of the new receivers equipped with a color curtain appears here. Either a changing or fixed color screen can be incorporated with the receiver and lend an added beauty and fascination to radio entertainment.

Fixed Color Curtain

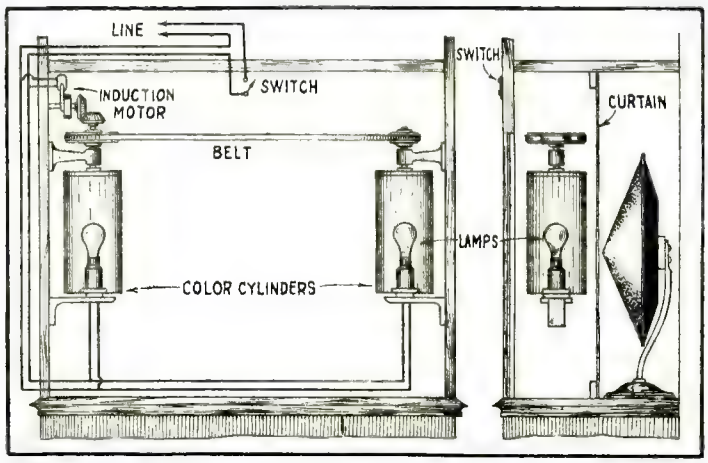
THE color screen is rather easily built and the construction of a fixed color curtain will be taken up first. The illustration shows the arrangements of parts with a miniature stage suggested. A frame approximately three inches wide and one inch deep supports the sockets, switch, curtain and figures. This frame slides into the cabinet being held in place by screws. A push-pull switch, a pleated curtain, preferably white, and a group of figures are shown. The two top lamps are yellow and the two bottom ones red, although other colors can be used. The lamps should be rated at about ten watts and the new type S-11 intermediate screw base decorative bulbs offer a wide variety of colors.

Mobile Color Curtain

The moving or changing color screen is illustrated and uses a small induction motor with the output shaft revolving at 1 r.p.m. It is fastened to the side of the cabinet with a bracket and coupled to the output shaft through gears is the color cylinder. The cylinder on the right is driven by means of a small belt and the pulley on the right is approximately one-half the diameter of the driving pulley, so that the cylinder at the right rotates at about 2 r.p.m. This rotation produces a slow change in the colors but a still slower speed may be obtained by reversing the pulleys which will change the speed ratio of 1:2 to 1:½ r.p.m. The slow rotation of the cylinders permits the use of a small motor but some reduction gearing must be used. Some motors, such as the General Electric 110-volt a.c. 60-cycle ten-inch fan motor already have a reduction gear attached for the purpose of oscillating the fan. This motor can be used by replacing the lug on the oscillator with a small pulley or by filing a groove around the lug. Universal motors should not be used, as interference will be experienced from the sparking at the brushes. In combination radio phonographs, the motor used to turn the phonograph disc can be employed to drive the color cylinder by attaching pulleys or reduction gears. Lamps are mounted inside the cylinders and a 25-watt bulb gives sufficient light. A switch is provided for turning the lights and motor on and off. If the switch is of the push-pull type, it can be (*Continued on page* 183)



A fixed color curtain is constructed as shown above. Four 10-watt lamps of two colors are placed between the two curtains.



The above illustration shows the parts necessary to produce the changing colors. The cylinders are revolved by means of a small induction motor, turning at a slow speed.

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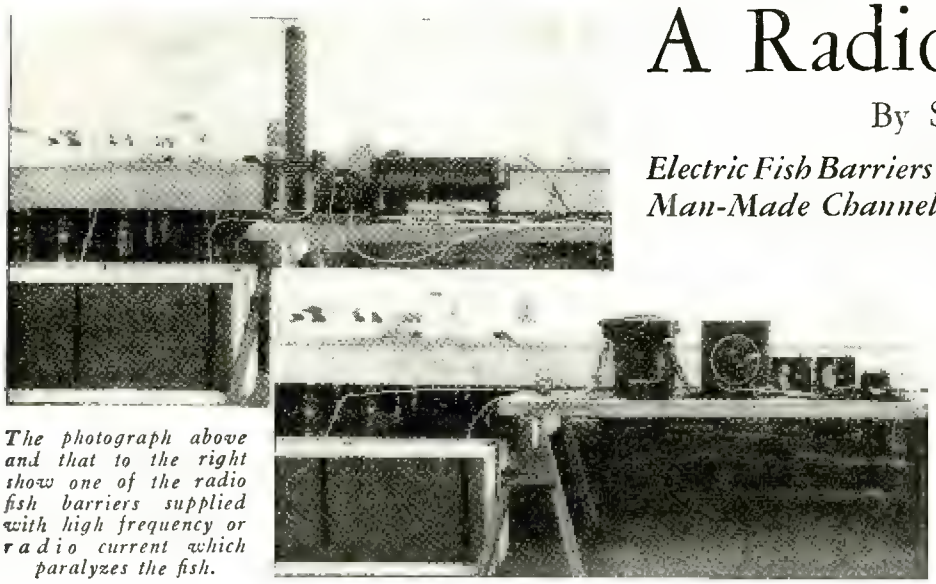
A Radio Fish Screen

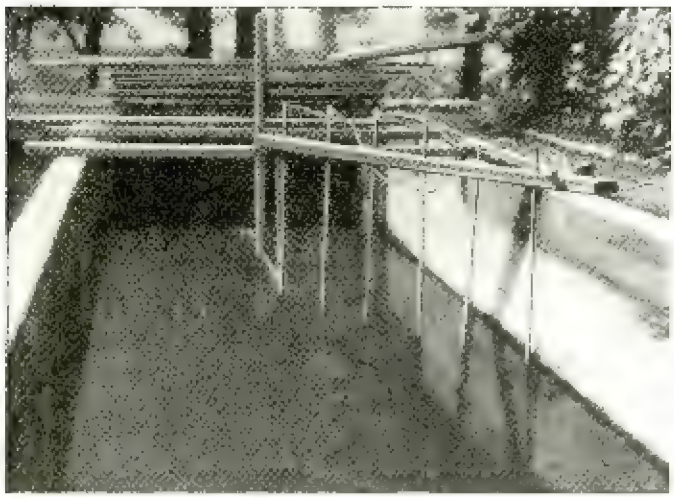
By S. R. WINTERS

Electric Fish Barriers Prevent Finny Tribe From Entering Man-Made Channels Where Death Would Be Certain



The photograph above and that to the right show one of the radio fish barriers supplied with high frequency or radio current which paralyzes the fish.

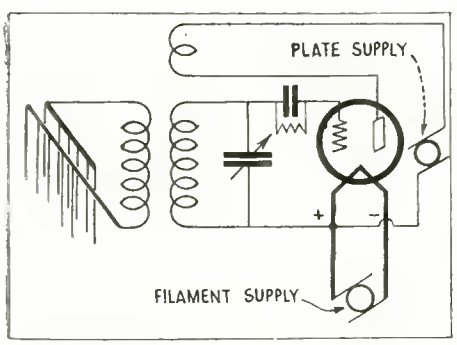
A RADIO fish screen—and thereby hangs a fish story! High-frequency or radio currents are now being employed in coaxing game and food fish to remain within the principal streams of waters and not stray into irrigation canals and other man-made channels whence they would be carried into places where death is inevitable because of a lack of food. These errant habits of fish, oddly enough, cannot be arrested by anything less violent than a stroke of paralysis; and so-called electric fish "stops," installed chiefly in Washington, Oregon, and California, have frequently electrocuted rather than merely electrified fish affected with wanderlust—killing them instead of administering just a stroke of paralysis so that they could be subdued into the sensible notion of remaining in the life-sustaining streams or channels of waters. This undesirable result of electrocuting the fish, by use of earlier models of electric screens, prompted a series of exhaustive tests in determining the "safety zones" of radio screens—if this term is permissible!



The above photograph shows one of the screens placed in a test tank. The Bureau of Fisheries has made many experiments and has developed a practical electric barrier.

radio-frequency currents supply this paralyzing force without delivering death-dealing blows.

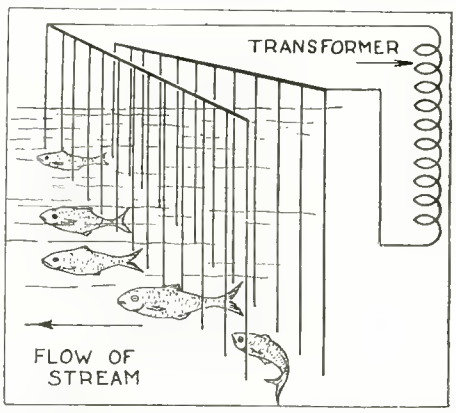
Radio or electric fish screens have been designed and built by F. O. McMillan, associate professor of electrical engineering at Oregon State College, working in conjunction with the bureau of fisheries. This method of diverting fish from irrigation canals, ditches, mill races and other watercourses more or less barren of food for the film tribe is not novel; the patent office has granted at least three patents on radio or electric screens, one of which was issued five years ago. However, the



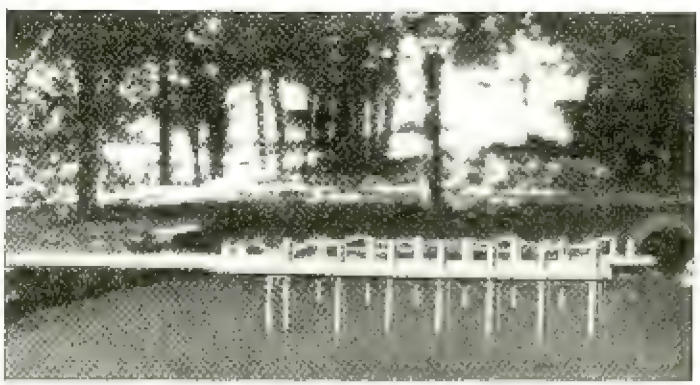
The schematic diagram above, shows in a simple manner how the screens are supplied with high frequency current by a vacuum tube oscillator.

Trying it on the Fish

A HIGH-FREQUENCY oscillator was placed in commission and thirty chinook-salmon 'fingerlings" or "baby" fish were subjected to a 500,000-cycle electric field; the plate voltages exceeded by more than one hundred times those ordinarily employed at 60 cycles. Despite this high potential, however, the fish failed to manifest visibly the presence of the electric field. This phenomenon is attributed to the plausible theory that these high-frequency or radio currents flowed on the *surface* of the water, between the electrodes, and that there was no appreciable electric field within the water. This, however, did not offer an acceptable excuse for not measuring the strength of the electric field in this artificial fish pond, with quite the precision that the engineer of a powerful broadcast station would determine the field intensity of the waves emanating from the radiating antenna. "A continuous-current test was made on a group of 30 chinook-salmon fingerlings," we are told by Professor McMillan, "using the direct current exciter in the hatchery's hydraulic power plant as a source of continuous potential. The *voltage-gradients* for paralysis were (*Continued on page* 178)



Above is a fish barrier supplied with 60 cycle alternating current. This type was used in most of the tests and proved to be quite satisfactory.



Above is a group of barriers such as those described here arranged for keeping fish in the proper waters.

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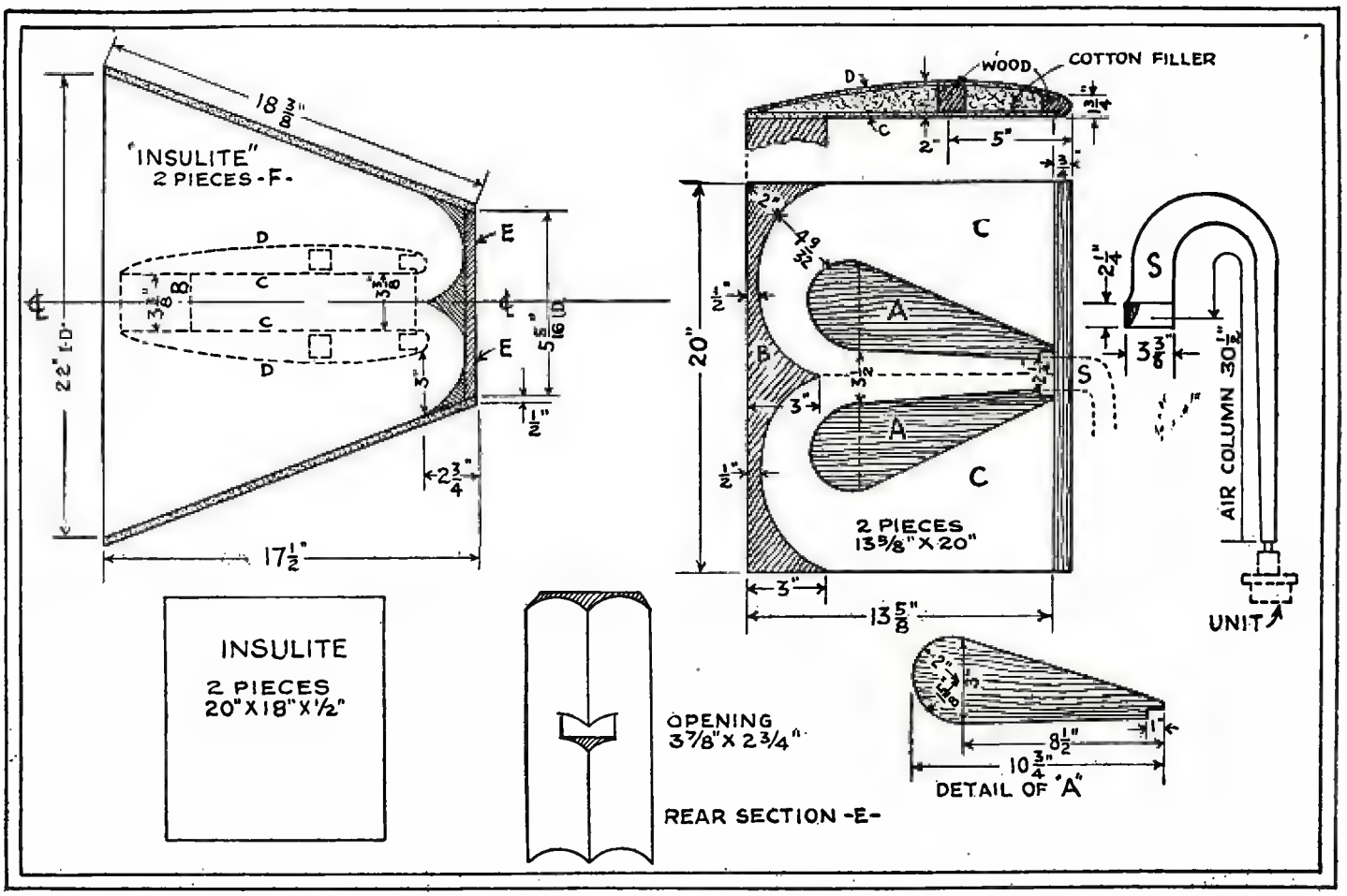
Making an Exponential Horn

By ERNEST ROMKEE



The drawing in the upper left hand corner shows a top view through the center of the horn. The opening for the unit in the rear section E is not shown in this view.

A sectional view of the horn through the center is shown above, together with details of the air column, dimensions of section A and a view of the rear section E showing the opening.

READERS will recall a somewhat technical description of a twelve-foot horn, in *Radio News* for August, 1927, and the explanatory cuts accompanying the article. Since a horn of these dimensions is out of question for use in the home, the writer set out to make one of smaller dimensions following as nearly as possible the figures given, which say the rate of expansion shall be the area doubled for each foot in length as the horn is extended from the small end.

Length of Horn

AN area of 400 square inches for the large end of the horn was chosen and the final result showed the horn would be between eight and one-half and nine feet long. This did not make a horn of such size as to be impossible for home use and one was built to these specifications. It had a very good tone but it often gave forth a sound like a man talking in a rain barrel. This might not have been noticed in a large room, but in a small room it was objectionable. Some time ago another horn was figured out on paper having an area of 400 square inches as before but in which the rate of expansion was changed to a doubling of the area each 8½ inches in length. Judging by the sound given by the larger horn, this seemed desirable and the finished horn proved the guess correct. The overall length of the present horn is about 78 inches.

The accompanying drawings give the rate of expansion at different parts of the horn and the builder will only need to increase the size of his drawings to the dimensions given to get the proper layout for his horn. A horn of these dimensions will fit nicely into a cabinet that measures 22 by 19 inches.

Materials Needed

THE material used in the horn, that is, in the largest part, is known as *Insulite* and procurable at any lumber dealer. It is a wood pulp composition about ½-inch thick. Other parts of the horn are made of thinner material known as *Beaver Board,* as there are two pieces that must be bent to make the desired shape for the interior part of the horn.

The oval pieces marked A in the diagram are built up of wood to a thickness of 3⅜ inches and should be planed smooth all around and a piece cut out of the rear end of each as shown in the drawing. This is for the small end of the horn and must be a good air-tight fit. The piece B is also made of wood 3⅜ inches thick and sawed to the shape and dimensions given. It is well to work the inside of this down as smooth as possible as this and the two pieces marked A form the air column in the inner part of the horn and are nailed and glued to the two pieces of *Beaver Board* marked C. The two pieces of *Beaver Board* D are next cut out and are nailed and glued to either side of the pieces C, with wood pieces to make a rounded end at the rear as shown and then nailed and glued at the front end to make the proper shape.

Assembly

THE four pieces of *Insulite* are next cut to the required size and nailed to a strip of 1 x 1 inch wood on the outside of each corner. Use plenty of glue here as elsewhere. The rear part of the horn marked E is next made by glueing and nailing strips of soft wood to a piece of the thick material and is built up to the proper shape with a thick putty made by mixing a quantity of asbestos cement with shellac. This cement makes a very smooth, hard surface which will not break or crumble and is not affected by moisture. Be sure the whole interior is as smooth as possible and no holes or cracks are left. It is well to give the whole interior of the horn a coat of shellac or varnish as the work progresses.

Mark center lines on the inside of the largest part of the horn and also on the front end of the center section B and after applying a liberal amount of (*Continued on page* 169)

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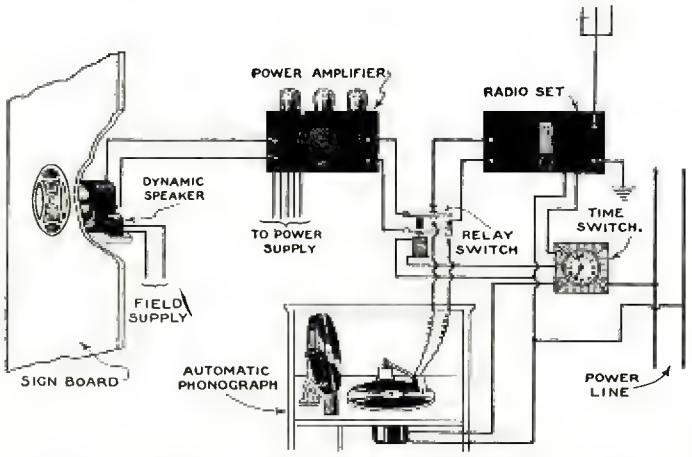
How Radio Is Used in Novel Advertising Stunt

"Talkie" Board Used by California Radio Company Gives Radio and Phonograph Reproduction

The photograph at the left shows the talking signboard. A dynamic speaker, radio receiver, and automatic phonograph are placed behind it.

A Talking Signboard

By R. B. DOHERTY



The above drawing shows the equipment and wiring diagram of a talking signboard, similar to that described here.

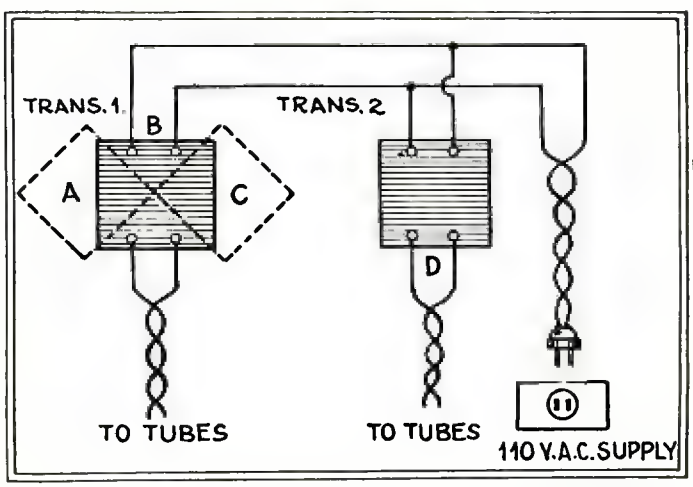
THE Southern California Music Co., of San Diego, California, has recently put into operation a talking signboard, the invention of Mr. Stewart Ashenberg. The board is forty-five feet long and fourteen feet high. A radio set is pictured upon the front. The speaker grill has been cut away and a neon tube placed therein draws attention to the source of sound which is furnished by equipment in back of the signboard. This equipment consists of a radio receiver, power amplifier, dynamic speaker, automatic phonograph and associated switching equipment and time clocks. The diagram shown here gives an idea of how this can be accomplished. A time-switch could turn on the radio receiver at a predetermined time and when no programs were being broadcast, the automatic phonograph would be used. The power amplifier, of course, could be employed with either the radio receiver or the phonograph and the music reproduced through the medium of a dynamic speaker. In the "talkie" sign shown here, the radio set is tuned to KFI, Los Angeles, and remains turned on from about 4 P. M. to 10 P. M. The sign lights and neon tube remain lit until midnight. A permanent hook-up with station KFI will enable programs to be broadcast in the morning and afternoon. The talking feature of this now famous sign has indeed attracted much attention, as would be expected. Crowds gather whenever programs of special interest, such as election returns and sporting events are being broadcast. Even while silent, the signboard has excellent advertising value.

Balancing External Transformer Fields

By JOHN F. RIDER

THE following suggestion, the outcome of an experiment, finds application in many home constructed A.C. receivers. An appreciable portion of the total hum encountered in an A.C. tube installation can be attributed to coupling between the filament transformers and the receiver wiring. The judicious use of two filament transformers to supply the audio system, one transformer feeding the intermediate audio amplifiers, and the other, the power tube and tubes in the radio frequency amplifier, presents a method of minimizing hum which has been found satisfactory.

The principle of the system involves the use of two filament transformers and the balancing or what is equivalent to the neutralization of the external fields of the transformer windings. This is accomplished by changing the phase of the fields, by reversing the connections to one of the transformer input windings and varying the position of the filament transformers with respect to each other. An idea of this can be obtained by referring to the accompanying illustration. Positions B and D of transformers 1 and 2 are normal. It should be noted, however, that the input connections are reversed. Transformer No. 1 is now shifted with respect to transformer No. 2 with approximate positions indicated by A and C. The spacing between the transformers need not be greater than 6 or 8 inches between centers. Using this arrangement with two 227's and two 250's, the total hum was only 62 millivolts and was inaudible one foot from the loud speaker.



The above illustration shows the use of two filament transformers and how they are placed for neutralizing the external fields of the transformer windings. This is accomplished by changing the phase of the fields, by reversing input connections and shifting transformer positions, as indicated at A and C.

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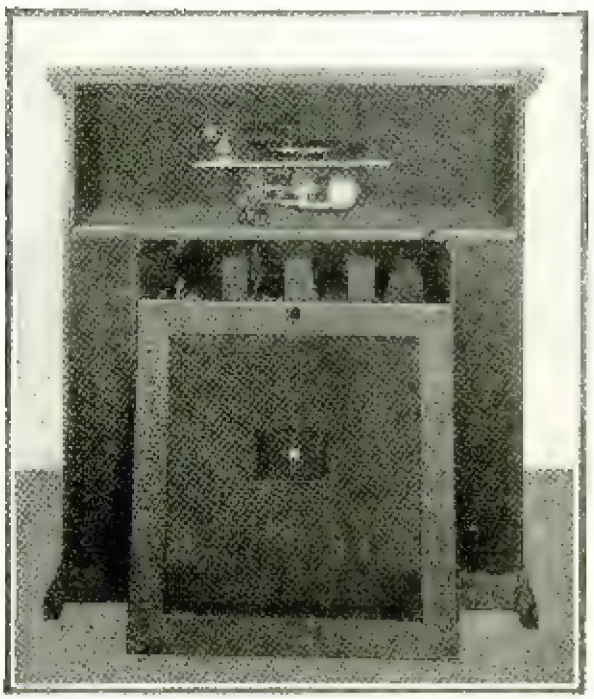
Part 1 of an Article Describing How to Build a Combined Radio Receiver and Electric Phonograph



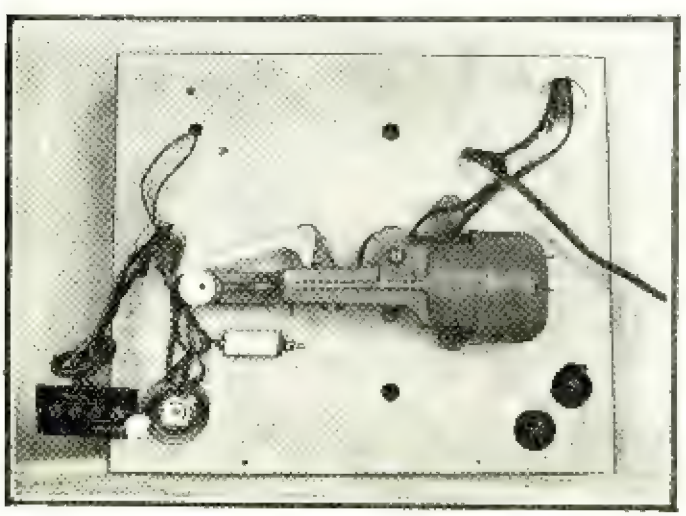
At the right is a photograph of the rear of the combination, showing at the top the electric turn-table and beneath this the receiver. A dynamic speaker is placed at the bottom.

For Those Desiring the Ultimate in Home Entertainment, the Electric Phonograph and Radio in One Cabinet Probably Offers the Best that Can Be Had

A Radio-Phonograph Combination

THE combination radio and electric phonograph with its ever increasing popularity offers what is undoubtedly the ultimate in home entertainment. When no programs are being broadcast, the electric phonograph can be turned on, or if one tires of the radio, it is simply necessary to operate two small switches for phonograph reproduction. The combination shown here was housed in the only suitable cabinet available; however, special cabinets for radio and electric phonographs can be obtained.

There is nothing difficult about the construction, and any good receiver can be used in conjunction with the combination. The audio amplifier which was used was chosen for its remarkable characteristics and will be described next month. A list of suitable amplifiers available from the manufacturers will also be given for those who do not care to construct their own.



The above photograph shows a rear view of the electric turn-table. The small induction motor is visible, as well as the volume control in the lower left-hand corner. Four pin jacks mounted on a bakelite plate shown at the lower left provide for amplifier and adapter connections.

The Turn-Table and Electric Driving Motor

AN electric turn-table complete with pick-up, switches, volume control and scratch filter was chosen for the phonograph. A small induction motor operates the turn-table and may be seen in the photograph.

The turn-table was placed directly under the top of the cabinet which is hinged, in order to allow records to be changed. At first, it was decided to place the amplifier in the top portion with the turn-table, but in the final construction, the amplifier was positioned on the shelf below as plenty of space was available. The rear view shows the combination only in the process of construction, so that the turn-table is exposed, but in the finished product, the turn-table was placed on a shelf suitably finished with motor hanging below. As will be seen in the photograph, the turn-table is mounted upon a panel so that it is only necessary to cut a section out of the shelf and drop the motor through. The turn-table panel is then fastened to the wooden shelf. A more workmanlike job, can be executed by setting the turn-table panel flush with the shelf. The shelf is supported on each side by cleats. The entire upper back portion containing the turn-table was then enclosed with a strip of wood. The leads from the phonograph to the amplifier below run through a hole in the shelf separating the turn-table from the radio portion. Both the set and amplifier were placed on the same shelf and can be seen in the rear view.

As the motor used in the turn-table is brushless, no interference due to sparking is experienced. A governor prevents chattering and the speed is uniform from the beginning to the end of the record. The acceleration is rapid and a speed control is arranged on the board. The pick-up has a natural tone and is completely free from distortion, assuring a clear quality of reproduction. Two switches on the turn-table panel provide for turning the phonograph on or off, and for changing from radio reception to phonograph reproduction, or vice versa.

Receiver

THE matter of the choice of a suitable set to use with the combination lies with the builder, but an all-electric set is recommended as being the best and most compact. Using a set of this kind, it is simply necessary to plug the combination into

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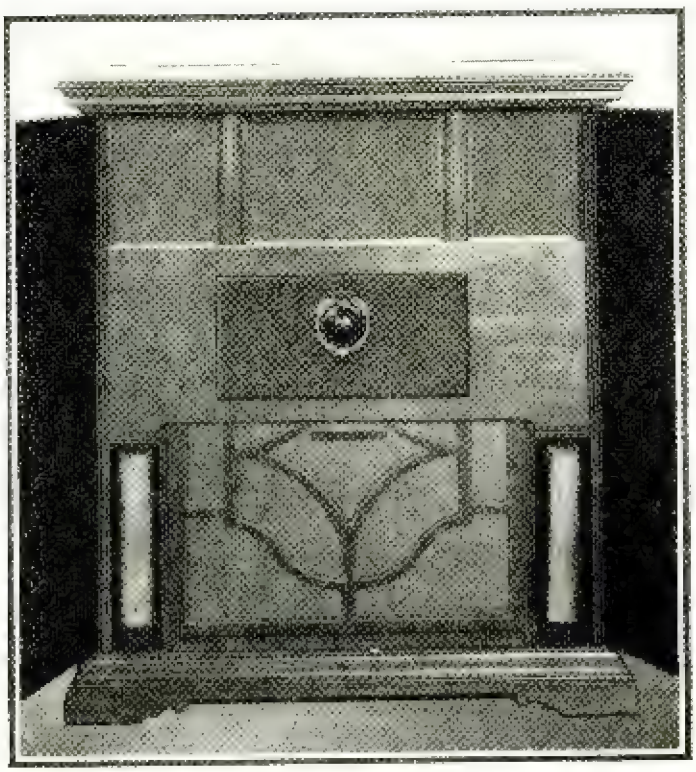
THE RADIO PHONOGRAPH

THE construction of an electric phonograph is detailed here. The builder can include any radio receiver that he wishes. For this reason and because individual tastes vary, no set will be described for this combination. The amplifier to be used with both the phonograph and radio will be described next month.

the light socket for operation. The receiver need not be shielded, unless shielding is required in its particular design, as no interference will be experienced from the small induction motor. If any other type of motor is used, it should be placed in a metal can and the receiver shielded with all shields connected to the ground. Power supply for the amplifier can be supplied by a separate eliminator which will also furnish the necessary "B" voltages for the receiver. Your present set and audio amplifier can be used satisfactorily in the combination.

The control panel for the set may be seen in the photograph showing the front view of the electric phonograph-radio combination. In order to make operation as simple as possible a single dial set was used. The wooden panel extending across the front of the cabinet has a hole cut out for receiving the set panel. It is best not to fasten the panel of the set to this front strip on the cabinet too securely, as the receiver may have to be removed for repairs. A small screw at each corner of the set panel is all that is necessary to hold the receiver in place.



A front view of the completed phonograph and radio combination is shown above. Individual construction may be varied somewhat, if a different type of console is used. The record albums fit into slots on either side at the bottom.

Loud Speaker

A MOVING coil type or dynamic loud speaker was used as a reproducer with the radio-phonograph combination. The speaker chassis and baffle are placed at the bottom of the cabinet. If the builder has a dynamic already housed in a cabinet or baffle box, the construction will be simplified. The front (see photograph) is covered with a grill work which extends from the set panel to the bottom of the cabinet and completely conceals the speaker. If space permits, it might be possible to use a folded exponential horn for the reproducer. Due to the fact that a high quality output is wanted, the use of a magnetic speaker is not recommended. It may be well to mention that the speaker baffle is rigidly fastened around its edge to the front of the speaker console compartment. The rear of the speaker compartment, and also, the set, amplifier and power pack sections are covered by a screen stretched over a framework. This allows for ventilation as the heat produced by the rectifier and power amplifier tubes is considerable. Furthermore, it is necessary to alleviate the back pressure which would be built up by the sound waves if the rear of the speaker compartment were enclosed.

The framework containing the metal screen or loose weave silk cloth fits into the back and is held in place by two small catches, so that it can be removed easily if any trouble shooting has to be done. On each side, at the front, a space has been allowed for receiving the phonograph record albums.

Consoles

ALMOST all types of consoles, providing they are large enough, lend themselves to radio-phonograph combinations rather easily. If the top is not hinged, and records cannot be changed that way, the turn-table can usually be reached from the front. If the speaker is not incorporated in the combination, a smaller console can be used.

The actual time taken in construction of the combination is not long and except for mounting the turn-table and baffle, it is merely a matter of assembling the different units. Those handy with tools will find no difficulty in making the combination and can easily change their present console to contain the phonograph. Old cabinets found about the house usually in the attic or cellar can ofttimes be revamped and used for consoles.

In the radio department of this issue will be found a description of a radio color curtain. This arrangement can be readily adapted to the combination described here and will add an additional touch of beauty by combining music and color. If the color screen is used, it should be placed in back of the speaker grill. By painting silhouette figures on the colored cylinders, it is possible to have fairy-like forms dance across the screen accompanied by music and color. This feature can be employed when using either the phonograph or radio.

Advantages

THE radio-phonograph combination has many advantages and finds a place in every home. The tone quality now obtained from electrically cut and reproduced records is excellent. Further, the combination provides the music you want when you want it. When static is troublesome or station programmes unsuited to the listener's mood, it is possible to pick your own programme by using the electric phonograph. When entertaining guests, the availability of the phonograph programmes will be appreciated, especially for dancing.

There is also an economical consideration for the radio-phonograph combination combines two musical instruments and a fine piece of furniture at a cost which is but little over the price of one.

Hints

FOR those who do not wish to build a complete radio-phonograph combination, it is suggested that the phonograph can be housed in a separate small cabinet of its own and the amplifier on the present receiver used with the phonograph when records are being played. This arrangement is less expensive and will give quite satisfactory results.

The average woodworker in his own shop can build a console with little difficulty. For finishing the cabinet, carved moldings can be purchased in a number of designs in any cabinet shop. The wood used is largely plywood and is easily handled. Painted furniture is in vogue at the present time, and close-grained wood of the cheaper sort can be used and will paint well. The grill work in the front can be cut out with a jig saw or a hand coping saw. After it has been completed, it is fastened to a frame. Loose-weave silk cloth is placed behind the grill-work, stretched rather tightly across the wooden frame. The grill portion may be seen in the photograph showing the front view.

Names of manufacturers furnished upon request.

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NEW RADIO DEVICES

Illustrated Here Are Some of the Latest Developed Radio Apparatus and Accessories

The above photograph shows the smaller model clock which combines a world time dial and a radio light socket antenna.

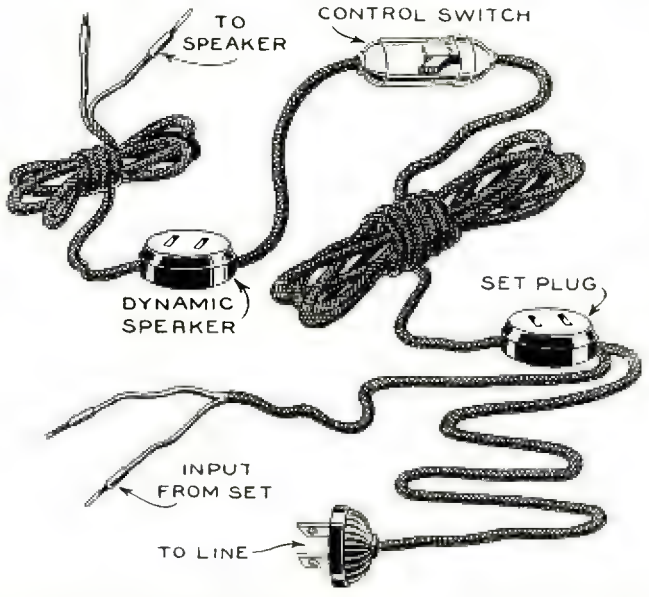
Clock

THE two clocks illustrated here are designed for use with a radio receiver. The smaller combines a light socket aerial and a universal timepiece described below.' The other is larger and incorporates a lamp. The world timepiece which is incorporated on the face tells the time in all parts of the world. A disc mounted on the hour hand turns with this hand. The face of the disc bears at various points, the names of numerous geographical locations. The glass covering the front has a small hole which corresponds to a hole in the disc. A pointed instrument allows the disc to be turned until the location at which the clock is used in under the hour hand, then the positions of the other points on the disc indicate the corresponding time.

The clock shown above is a combined time piece, lamp and aerial.

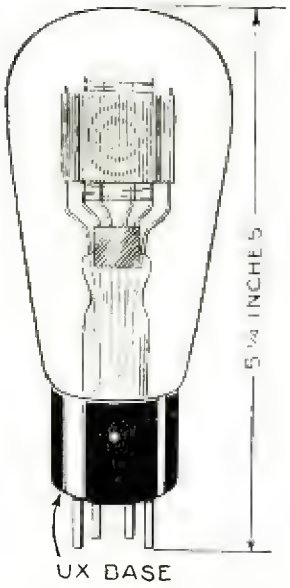
Remote Control Cord

A NEW YORK manufacturer is now making a remote control cord which by a snap of a switch will turn on or shut off the power to both an electric set or dynamic speaker, at a distance of fifty feet from the receiver. The cord accommodates a magnetic type or dynamic type speaker, and will operate an additional speaker at a remote point, at the same time the speaker enclosed in the receiver is being used. Pin tips are provided for plugging into the set if separate speaker is used.



The above illustration shows the remote control cord which allows the radio to be turned on or off at a distance up to fifty feet from the set. It will also operate an additional speaker.

New Screen Grid and Power Tubes



The above illustration shows the 245-type power amplifier tube for supplying a large undistorted output.

TWO new tubes have been announced by a leading manufacturer. One is an A.C. screen grid tube which has a low value plate impedance, considering the high amplification factor. The tube employs a heated cathode and uses 2.5 volts A.C. or D.C. on the filament. A 5 prong UY base is therefore required. The characteristics of the type 224 A.C. screen grid tube are given below.

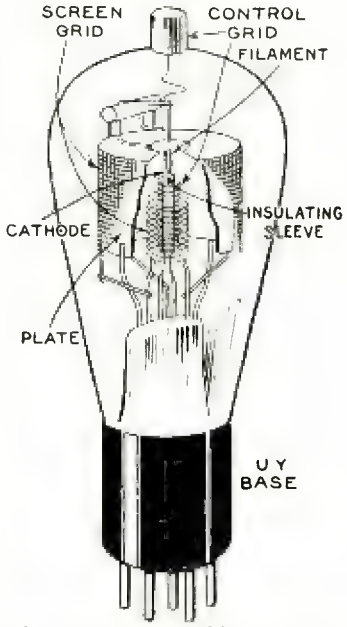
Filament volts (A.C. or D.C.)	2.25-2.5
Control-grid volts	1.5
Screen-grid volts	75
Amplification constant	420
Plate resistance, ohms	400,000
Mutual conductance	1,050
Plate current, milliamps	4

The new screen grid tube can be used in all positions where previous types of these tubes have been employed.

The intermediate power tube is intended for use in the last stage of A.F. amplification and is provided with a standard UX socket. The filament may be operated from a storage battery or a step-down transformer. Following is the rating and data of the 245 power tube:

Filament voltage 2.5 volts A.C. or D.C.
Filament current.....1.5 amperes
Plate voltage 180—250 volts (maximum)
Grid voltage (C-Bias)....33—50 volts
Plate current 26—32 milliamperes
Plate resistance.....1950—1900 ohms
Amplification constant.....3.5—3.5
Mutual conductance 1800—1850 micromhos
Undistorted power output 780 –1600 milliwatts

The value of 250 volts with a bias of 50 volts need only be used where there is sufficient signal to secure the full grid swing and where maximum power output is desired.



The A.C. screen grid tube is illustrated above. The plate and screen grid have been broken away to show the position of the elements.

Names of manufacturers furnished upon request

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A Monthly Question and Answer Department Conducted with a View Toward Helping Radio Constructors and Experimenters

RADIO ORACLE

Devoted Only to Queries of General Interest

"A" Eliminator

(711) Robert Shuter, Oklahoma City, Okla., asks:

Q. 1. I have a 5 ampere charger using a lamp as a rectifier. Can you advise me how I may convert the charger into an "A" eliminator?

A. 1. This type of charger can easily be converted into an "A" eliminator by filtering the output. An "A" choke and two "A" condensers of 2000 or more microfarads capacity, connected across the output on either side of the choke, form a suitable filter. An electrolytic filter could, of course, be used, as well as a dry "A" filter. The latter consists of two condensers and a choke coil, housed in a metal case. These are now available from several manufacturers.

Stabilizing Method

(712) A. T. Maxwell, West Philadelphia, Pa., asks:

Q. 1. Can you give me a method for stabilizing radio frequency stages without balancing, similar to that used in the Atwater-Kent receiver?

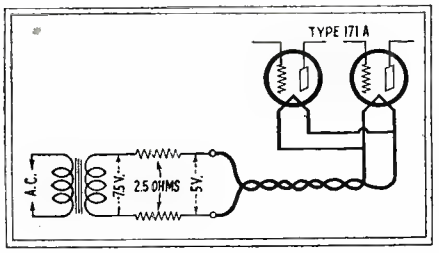
A. 1. The coils used are wound with fine wire upon a small form and are enclosed in metal shields. The number of turns on the primary coils of the radio frequency transformers may be increased without loss of stability or tendency to oscillate. In the antenna circuit a radio frequency choke coil is used which prevents the passage of the radio frequency energy of the received signal. The reaction of this inductance for audio frequency current is low, thereby shunting low or audio frequency currents from the grid of the first radio frequency tube, thus preventing the production of low or audio frequency currents in the receiver. In the grid circuit of each of the radio frequency tubes, except that in the first stage, are placed resistances of such a value as to prevent regeneration or oscillation. To increase stability, the plate supply can be isolated by using filters. A further margin of stability will be gained if the radio frequency transformer secondary is tapped about one-quarter of the way from the grid end and this tap connected to the grid of the vacuum tube. The tuning condenser is placed across the total secondary winding. In this way, the tendency to oscillate and effects of undesired coupling are minimized without substantially reducing the desired voltage amplification of the circuit. This method comprises reducing all fluctuating voltages impressed upon the grid, by reducing the impedance of the input circuit of the tube and decreasing the step-up ratio between the input circuit and the output circuit of the preceding vacuum tube, so that the desired signal voltage fluctuations are maintained upon the grid. The feed-back voltage impressed upon the grid is reduced in much greater proportion than is the signal voltage. The impedance of the primary winding should approximate the impedance of the circuit in which it is used, whereby the normal value of the signal voltage impressed upon the grid is restored.

Reducing Transformer Voltage

(713) Felix Simons, Houston, Texas, asks:

Q. 1. I have a transformer with a 7½ volt filament winding designed for operating a 210 tube. How can I cut this down to 5 volts, so that I may light the filaments of two 171-A tubes. A diagram of the method used will be appreciated.

A. 1. The problem of cutting down the voltage delivered by the 7½ volt transformer is an easy one, and it will simply be necessary to use a resistor in series with each leg of the winding. This is done in order to preserve the electrical balance of the winding which would be destroyed if only one resistor were used in series with one of the leads. In



The voltage delivered by a filament transformer can be reduced by using a resistance in series with each secondary lead. The transformer is either center tapped or has a resistor across the winding.

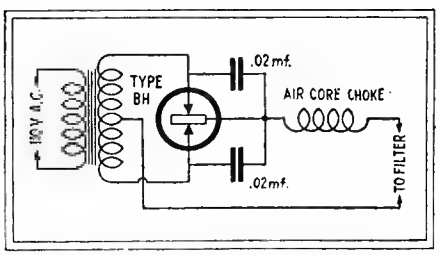
order to operate two 171-A tubes which together draw a half ampere of current, the resistance required will be 2.5 ohms in each leg, since the voltage drop required is 2.5 volts. The resistors should be of sufficient capacity to carry the load.

Improved Buffer Circuit

(714) Jack Kupperman, Akron, Ohio, writes:

Q. 1. Will you please publish a diagram of the new buffer circuit which was recently announced by Raytheon?

A. 1. You will find illustrated on this page the circuit diagram of an improved buffer condenser circuit. If the gas in the rectifier tube should break down, a periodic disturbance would be set up and for this reason buffer condensers are used which absorb the disturbance. In previous circuits two high voltage 0.1 mf. condensers were connected across the transformer secondaries. It has been found, however, that by using the hook-up shown here, it



The circuit diagram of an improved buffer condenser circuit appears above.

is possible to obtain superior performance with condensers having a capacity as small as .02 mf. These should be placed as closely to the terminals of the tube as possible. It will be noted that the buffer condensers are operating at a higher voltage than in their former location. A radio frequency choke adds to the general efficiency of the circuit and keeps any R.F. disturbances from reaching the filter circuit. This small air core choke may consist of 100 turns of No. 34 D.C.C. wire wound on a form 1 inch in diameter. The effectiveness of the new buffer condenser arrangement depends upon the use of short connections. The newly designed buffer condenser circuit has been developed with an improved power unit utilizing a single core flux bucking filter choke.

Forming Rectifiers

(715) Albert Nesbit, Hamilton, Ontario, Canada, writes:

Q. 1. How may aluminum-lead electrolytic rectifiers for a battery charger be formed and what indication shows when they are ready for use?

A. 1. The aluminum electrode in a rectifier of this sort must be covered with a film of hydroxide of aluminum and the process by which this film is obtained is known as "forming." This can be done by connecting the rectifier to the output of a toy or bell ringing transformer delivering about 10 volts. After the aluminum plate turns a light grey color, the rectifier is ready for use. When an electrolytic charger is not in use for a long time, the film on the aluminum electrode will gradually disappear and the rectifier must then be reformed. The loss of the film can be prevented by removing the electrodes from the solution and wiping them dry if the charger is to remain inoperative for any length of time.

Edison Battery

(716) Hal Coytes, Wichita, Kansas, asks:

Q. 1. What is the chemical action which takes place in the Edison storage battery?

A. 1. The fundamental action which occurs is the oxidation and reduction of metals in the electrodes. Neither the metals or their oxides dissolve or are combined. The water of the electrolyte is decomposed by charge and discharge, but it is again reformed in equal quantities and therefore, its conductivity and density are the same over a long period of time. Since the active materials of the plates are insoluble in the electrolyte, no chemical deterioration takets place. In charging, the nickel in the positive plate is changed to a higher oxide and reduction takes place at the negative plate where the iron oxide is changed to metallic iron. The oxidation and reduction are accomplished by the oxygen and hydrogen set free by the electrolytic decomposition of the water, while the battery is on charge. During discharge a reversal of the above action takes place and the hydrogen reduces the higher oxide of nickel to a lower oxide and the oxygen oxidizes the iron to iron oxide.

The positive plate of the cell is made of perforated steel tubes filled with alternate layers of compressed nickel hydroxide and metallic nickel flakes. These tubes are rigidly clamped in a steel frame. The negative plate is built up of a large number of rectangular pockets filled with powdered iron oxide. The pockets are enclosed in a corrugated steel grid forming the negative plate. The elctrolyte is an aqueous solution of potassium hydroxide, or caustic potash, having a specific gravity of 1.400. This hydroxide, if exposed to the air, combines with the carbon dioxide, forming potassium carbonate. For this reason the cells must be airtight. However, it has no effect on the steel containing jars which is an advantage over the lead acid cell.

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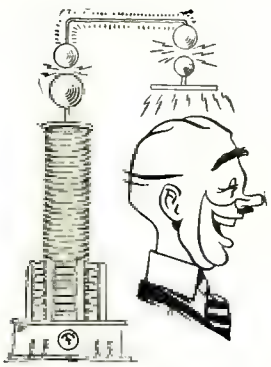
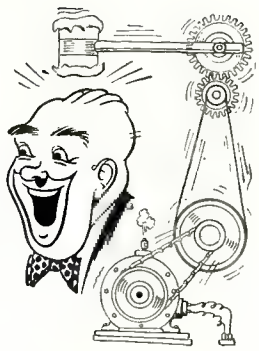


A Monthly Fun Page for Those Who Enjoy a Laugh

Scientific Humor



Original Jokes for Our Readers by Our Readers

MANY LIKE THIS, BUT FEW LIKE THIS

NAYBER: "What gave you that black eye?"

JONES: "The fireless cooker."

NAYBER: "Impossible!"

JONES: "That's what I thought till I tried to fire her this morning."

—J. R. Hornbrook.

THAT IS DIFFICULT

"There is just one thing I cannot understand."

"You are far too modest!"

"Why Swiss cheese should be full of holes when it is the limburger that needs the ventilation."

—R. M. Pruitt.

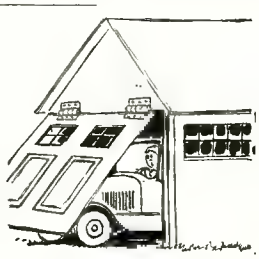
AS STRONG AS ANY

Many of the passengers were crossing the sea for the first time, and were experiencing the usual effects. As they were standing at the rail, broadcasting into the sea, the captain came by. Being a jovial fellow, he clapped one of the passengers on the shoulder, remarking, "You seem to have a weak stomach."

The passenger turned his green face toward the captain. "Well, I don't know," he murmured weakly, "I seem to be getting as much distance as any of them."

Booth Mooney, Reporter No. 35,202.

WE'LL TRY IT



BRIGGS: Why have you got the end of your garage on hinges?

GRIGGS: Because my wife can't always stop the car.

—M. H. Gibson.

NOT RECOVERED YET

PROF. OF BIOLOGY: What is a caterpillar?

PUPIL: An upholstered worm.

—John T. Talton, Jr.

First Prize $3.00

PHYSICALLY SPEAKING?

FIRST STUDENT: Why do you squeeze your girl friend so tight?

SECOND STUDENT: The prof said, that the temperature increases with pressure."

—Jay E. Zack.

TO TRAIN

HE: You say she has a trained voice?

SHE: Yes.

HE: I thought it sounded like a railroad.

—Lawrence Upton.

ALL jokes published here are paid for at a rate of $1.00 each; $3.00 is paid for the best joke submitted each month.

Jokes must have a scientific strain and should be original.

Write each joke on a separate sheet of paper and add your name and address to each.

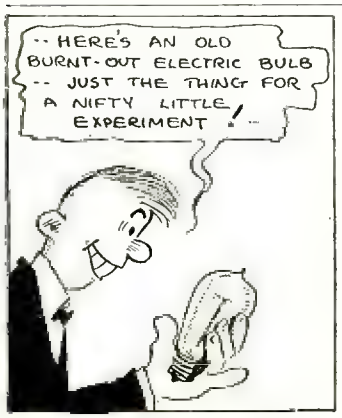
Unavailable material cannot be returned.

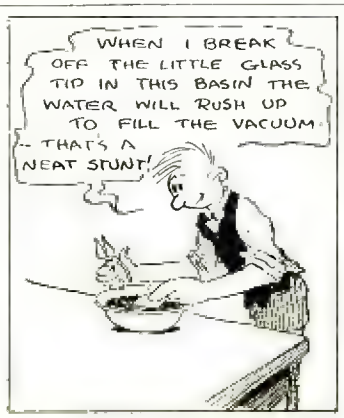
PAINTING A MALE

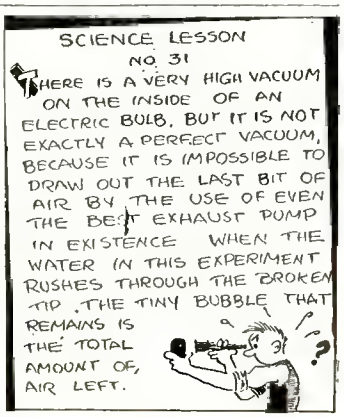
MINNIE: "I'm sick and tired of that old fruit picture in our dining room."

GRANDMA: "I'll take it down if you'll let me hang that Marine you brought home last night."—*J. Sprager.*

SCIENTY SIMON SCIENTIST






SCIENCE LESSON NO. 31
THERE IS A VERY HIGH VACUUM ON THE INSIDE OF AN ELECTRIC BULB, BUT IT IS NOT EXACTLY A PERFECT VACUUM, BECAUSE IT IS IMPOSSIBLE TO DRAW OUT THE LAST BIT OF AIR BY THE USE OF EVEN THE BEST EXHAUST PUMP IN EXISTENCE. WHEN THE WATER IN THIS EXPERIMENT RUSHES THROUGH THE BROKEN TIP, THE TINY BUBBLE THAT REMAINS IS THE TOTAL AMOUNT OF AIR LEFT.

USES FOR CLOUDS

"Yes," said the timid passenger to the airplane pilot, "I understand I'm to sit still and not be afraid and all that; but tell me, if something does happen and we fall, what shall I do?"

"Oh, that's easy," said the pilot. "Just grab anything we're passing and hang on."

—Salvatore Gidvide.

CHEATED

"Out in the country where I spent my vacation they gave me one of those 3-season beds."

"Never heard of them."

"No spring!"

—Elsie Konter.

ALONG MILKY WAY

PASSENGER: "Airplanes will never be popular among the smart set."

PILOT: "Why?"

PASSENGER: "There is no place to park."

—Gilbert Gerow.

NEEDS A LIFE PRESERVER

NOISY SOUP-IMBIBER (in restaurant, as neighbor turns around): "Whatcher lookin' at?"

THE OTHER: "Sorry I thought you had fallen in."—*Harrison Walrer.*

PAGE RIP VAN WINKLE

"I heard you got on one of these slow trains while touring through Arkansas."

"Yes, the trains were so slow, the only way we could tell in which direction we were going was by looking out of the window to see on which end of the train the engine was."

—Ronald A. Eyrich.

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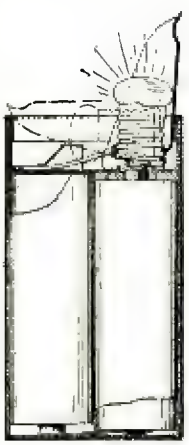
LATEST PATENTS

Automobile Accessory

No. 1,701,696, issued to Clark D. Parsons. The device shown above is an accessory attachment for use as a map or memoranda holder. A movable arm is supported on the windshield frame and the holder hinged to the free end of this arm, so that it may be placed in any desired position. It is also possible to swing the holder down, so that it rests on the steering wheel for writing purposes.

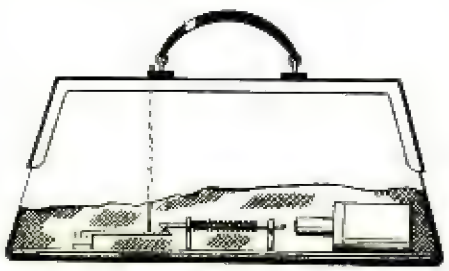
Battery Hand Lamp

No. 1,701,093, issued to John S. Zook. The small lamp shown has an incandescent bulb in a removable holder, so constructed, as to be capable of being flipped by the thumb or finger into either the operative or inoperative position. A cup is arranged above the battery and means are provided within the cup to maintain the base of the bulb in contact with one pole of the battery when in operative position. In an inoperative position, the bulb is at right angles to the battery.



Burglarproof Satchel

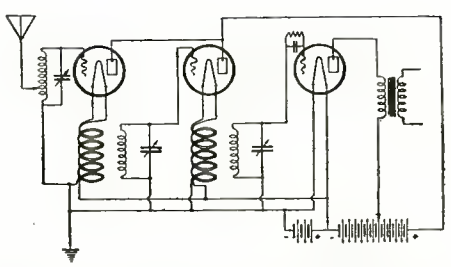
No. 1,791,799, issued to Virgil A. Smith. The object of this invention is to provide a satchel structure and time controlled bomb which is designed to foil the attempts of burglary, by discharging a suitable chemical, such as tear gas. The bomb containing the chemical and also an explosive charge are placed upon a suitable mounting. Connected with the explosive charge is a time fuse designed to be ignited by the owner. The cap which ignites the fuse is operated by a firing pin at the top near the handle.



Notice to Readers:

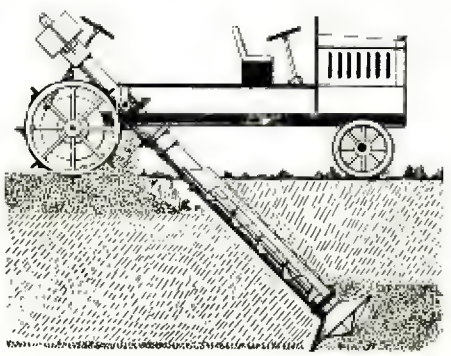
These illustrated and described devices have recently been issued patent protection but are not as yet, to our knowledge, available on the market. We regret to advise that it is impossible to supply the correct addresses of inventors of the devices to any of our readers. The only records available, and they are at the Patent Office at Washington, D. C., give only the addresses of the inventors at the time of application for a patent. Many months have elapsed since that time, and those records are necessarily inaccurate. Therefore, kindly do not request such information, as it is practically impossible to obtain up-to-date addresses.

Radio Frequency Circuits



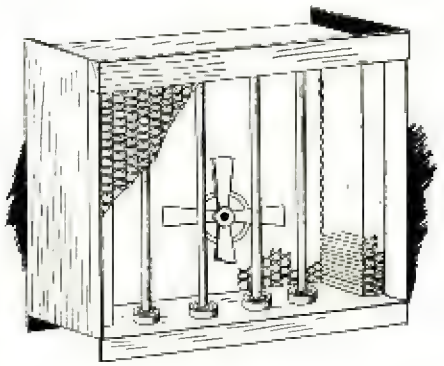
No. 1,700,393, issued to Anthony Winther. The circuit shown above is an improvement in R.F. amplifiers and has been designed so as to overcome the difficulties previously encountered in un-neutralized stages. Previously, the R.F. circuits in use were not as effective in selecting relatively strong signals. Another difficulty arises through the capacity of the grid and plate in the tubes. The filament has far less capacity than the plate or grid and in the present invention the primary inductance of the output circuit is placed next to the filament leads.

Apparatus for Digging Ground



No. 1,701,678, issued to Max Jaeger. The device shown above provides a means for digging sub-soil or ground from below the surface without removing the top soil. A cutter loosens the soil and a conveyor tube carries it to the surface. The cutter and conveyor which is of the helical type are revolved by gears actuated by the motor of the truck on which the apparatus is placed. The inclination of the digging apparatus can be varied by the operator. In order to prevent clogging, the worm in the smaller portion has a larger pitch than that in the lower end portion of the tube.

Air-Heating Radiator



No. 1,701,096, issued to Robert T. Bowling and Harry L. Cobb. This invention has been designed for transforming intense heat generated by electrical energy within a small area to a heat of lower temperature over a much larger area within a short period of time. A cellular radiator is used for diffusing the heat, and a current of air passing through the cells carries the heat away, distributing it uniformly.

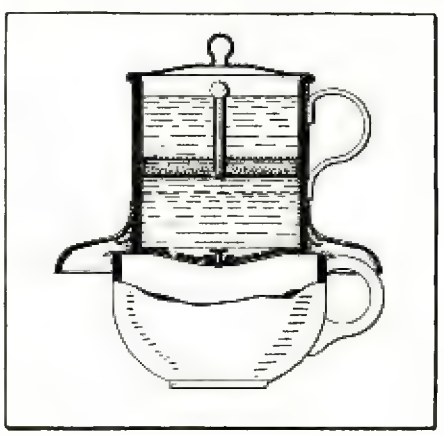
Boat

No. 1,701,925, issued to George G. Kisevalter. A large proportion of power in ordinary boats is used in overcoming frictional resistance of water. In the present invention,

this resistance is reduced by using a special propelling device which lifts the forward portion of the boat out of the water. This propelling device consists of a large paddle wheel extending across the hull. With a sufficiently high speed of rotation, a vertical pressure component is created which tends to lift the hull.

Beverage Maker and Dispenser

No. 1,701,194, issued to Fritz Rosenstein and Edward Bendheim. The device shown below is a compact container in which a quantity of a beverage such as tea or coffee may be kept hot and fresh and may be served to the individual user when desired. The individual beverage maker has an insulated container with a valve seated in a bottom outlet. Means are provided for unseating the valve and causing the contents of a container to pass into a receptacle.



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A Monthly Scientific Question and Answer Page

The Oracle

Since the Space is Limited, Queries of General Interest Only Can Be Answered Here

The "Oracle" is for the sole benefit of all scientific students. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be published. Rules under which questions will be answered:

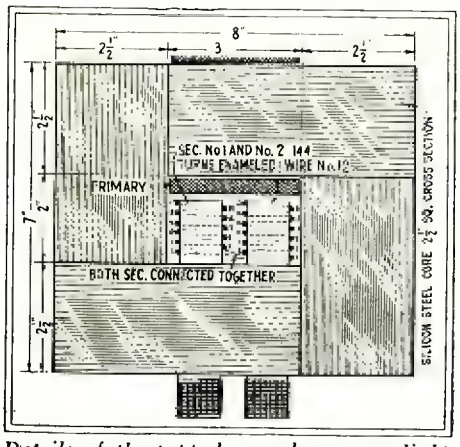
1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink; no penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions addressed to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of 50 cents is made for each question. If the questions entail considerable research work or intricate calculations, a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

Stage Lighting Transformer

(2311) John W. Hastings, Fresno, California, writes:

Q. 1. I wish to construct a dimming device for use with stage lights and amateur theatricals. The current supply is 115-volt, 60-cycle A.C. I believe a transformer with tapped secondary would be suitable. Can you give me the constructional data for such a transformer?

A. 1. Details of the transformer will be found in the drawing appearing on this page. A silicon steel core having a square cross-section is used. This is built up from four stacks of laminations, although it would be possible to use any other suitable method of core assembly. The core is 8 inches long and 7 inches wide with a window 3 inches by 2 inches. The primary consists of five layers of No. 10 enameled wire wound 25 turns per layer. Two secondaries are used in preference to one, as it would be difficult to maintain good insulation and, at the same time, to obtain sufficient taps were only one secondary used. In order to prevent overloading, the transformer secondary must not be called upon to supply more than 12 amperes of current. The first secondary has six turns of No. 12 wire on the bottom layer and eleven layers of twelve turns each, and on the top, another six-turn layer, making a total of 144 turns. This winding is tapped at the 18, 30, 42, 54 turn, etc. The second secondary has twelve 12 turn layers tapped at every twelfth turn. The voltages supplied to the circuits will be practically independent of the magnitude of the load, providing, of course, that the transformer is not overloaded. The tap switch should be so constructed that there will be no danger of connecting two adjacent taps together, as this would result in short-circuiting a portion of the secondary coils and the transformer would heat excessively. Any number of lamp circuits can be supplied with a variable voltage by using additional taps and switches.



Details of the tapped secondary stage lighting transformer are given above.

Fuller's Earth and Graphite

(2312) H. Garbe, Shattuck, Okla., asks:

Q. 1. Can you list briefly the main uses of fuller's earth. I would like to use this information in connection with the chemistry course which I am now taking.

A. 1. According to the U. S. Bureau of Mines, Dept. of Commerce, fuller's earth is used mainly as a filtering medium in bleaching or clarifying fats, greases and mineral and vegetable oils. It was originally used in fulling woolen cloth and derived its name from this use. However, it is little used for this purpose today. In the manufacture of pigments for printing wall paper, in detecting coloring matters in certain food products, as a substitute for talcum powder, and in medicine as an antidote for alkaloid poisons and as a poultice, fuller's earth finds much use. It is also used in deliming hides in the manufacture of leather, in the manufacture of hand soaps, concrete waterproofing, and asphalt preparations.

Q. 2. Also list the uses of graphite in industry.

A. 2. Graphite is used chiefly in the manufacture of foundry facings, paints, pigments, crucibles, pencils, commutator brushes, stove polish, lubricants, retorts and battery plates. The uses of graphite have so greatly developed after the war that the production of artificial graphite exceeds that of the natural crystalline graphite. Since 1910, except for 1915 and 1920, the output of manufactured graphite has exceeded the combined output of domestic amorphous and crystalline graphite.

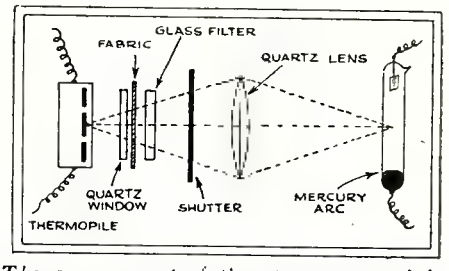
Ultra-Violet Light Transmission of Fabrics

(2313) J. Worthington Kent, Las Vegas, Nevada, asks:

Q. 1. I recently read about some experiments conducted by the U. S. Bureau of Standards, in connection with the transmission of ultra-violet rays through various fabrics. Additional information and a drawing of the apparatus used will be appreciated.

A. 1. In a paper by W. W. Coblentz, R. Stair and C. W. Schoffstall, printed in the August, 1928, issue of the Bureau of Standard's Journal of Research, measurements of the transmission of ultra-violet and visible radiation through various fabrics are described. The source of radiation was a quartz mercury arc lamp from which the ultra-violet rays were obtained by filtration through a purple glass filter and the visible radiation eliminated or isolated by a special yellowish-green glass. The drawing upon this page shows the arrangement of the apparatus with the image of the quartz mercury arc burner focused upon a bismuth-silver thermopile by means of a quartz lens. The thermopile was covered with a window of quartz to exclude long wavelength, low temperature radiation from the sample under test, which becomes heated when exposed to the lamp. Of course, this effect was negligible when thin cloths were used. The sample under examination was placed over the quartz window, as close as possible to the thermopile, so as to intercept the radiation which comes from the underside of the cloth. The cloth was held flat by placing over it the filter used for isolating either visible radiation or the ultra-violet. The electric current generated by the thermopile was measured by means of a galvanometer and by noting the deflection with and without the cloth placed over the thermopile, the percentage of transmission was obtained. By examining black and white samples of the same material, it was found possible to eliminate the effect of the radiation transmitted through the openings between the individual threads and thus determine the amount of radiation transmitted directly through the yarn.

Tests were made on fabrics of close weave and open weave, twill, satin and voile. The results obtained with these different weaves showed that if the materials have the same weight, there is little difference in the amount of ultra-violet transmitted through bleached samples of cotton, linen, viscose rayon, and cellulose-acetate rayon. Fresh, white, natural silk is almost as transparent as bleached cotton, while wool is only half as transparent to ultra-violet radiation as bleached cotton. When the fabric is dyed or yellowed with age, the ultra-violet transmission is greatly decreased.



The arrangement of the apparatus used for determining the ultra-violet transmissive properties of fabrics is shown above.

The average bleached sample of linen transmitted practically as much of ultra-violet as bleached cotton, but the transmission of the unbleached material was low.

After deducting the light transmitted through the openings between the threads, the transmission of ultra-violet radiation through bleached white threads was found to be as follows:

Viscose rayon varies from 16 to 27 per cent.
Cotton varies from 14 to 21 per cent.
Cellulose-acetate rayon varies from 11 to 29 per cent.
Silk varies from 14 to 18 per cent.
Linen varies from 7 to 16 per cent.
Wool varies from 5 to 15 per cent.

A rapid decrease in the transmission of ultra-violet radiation was noted when the fabric was dyed orange, yellow, green or tan. Yarns so colored were almost opaque to the ultra-violet. Pink-colored fabrics, however, were found to be an exception and transmitted the ultra-violet radiations. As it is not practical to have all fabrics uncolored, a gain in ultra-violet transmission can be obtained by using an open-weave cloth. Open-weave silk and heavy wool yarns compared favorably with cotton and rayon for transmitting ultra-violet radiation. The above data was made by using only a single layer of the fabric. It is evident that the transmission of ultra-violet radiation and visible radiation would be much less in the case where more than one garment is worn.

The ultra-violet rays of the sun are the producers of sun-burn and in general are very actinic, acting strongly on the sensitized photographic film.

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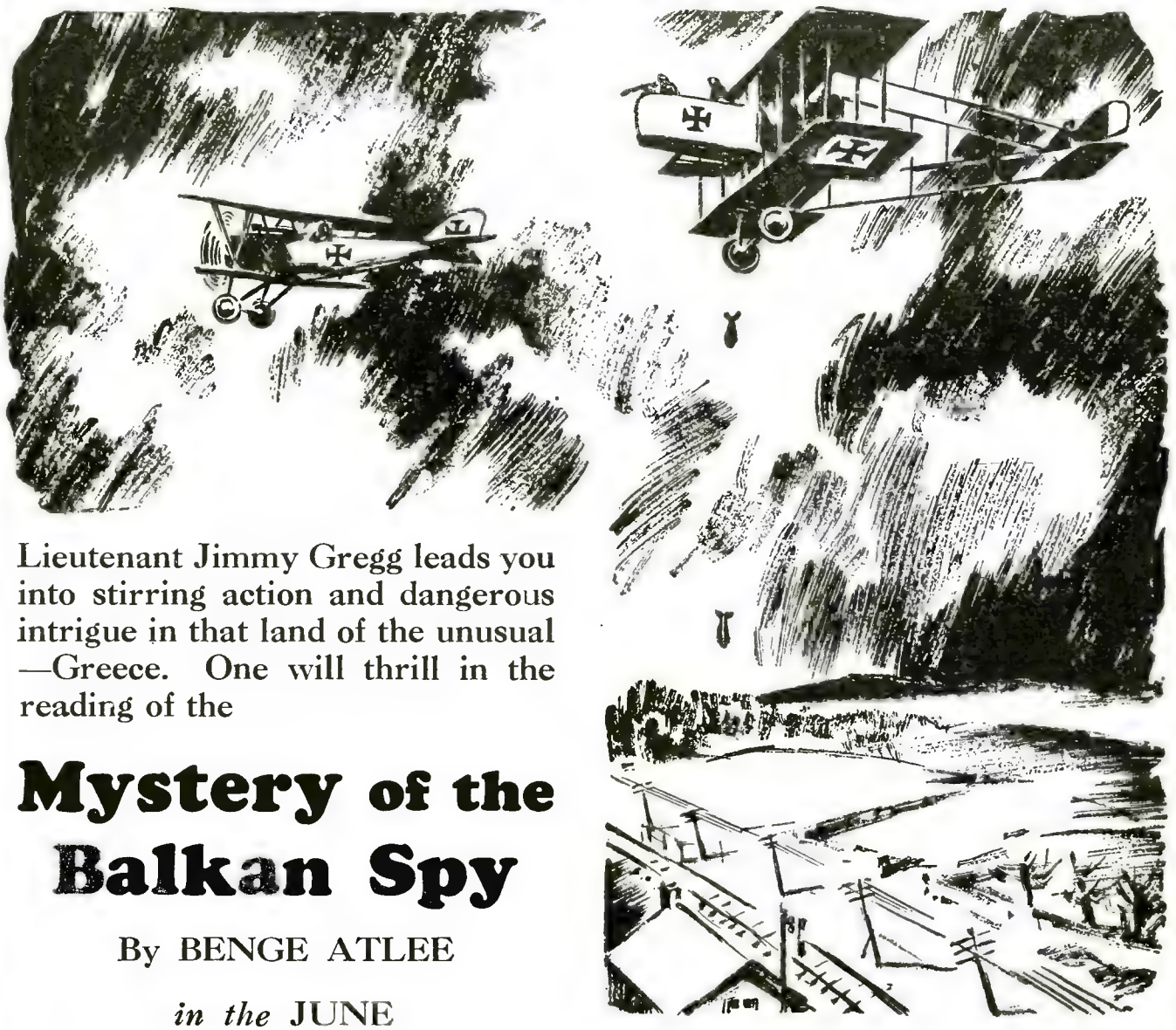
Cunning in the Clouds



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Time, Space and Relativity

By Donald H. Menzel, Ph. D.

(*Continued from page* 125)

conceive of energy's possessing mass.

R: That shouldn't be so hard for you. Here is a disk of paper—soft and flexible. Spin it and it will cut wood as cleanly as a metal saw (Fig. 3). A motionless chain or leather belt will lie limply. But if it slips from a rapidly revolving pulley (Fig. 4) it will stand erect and roll like an iron hoop. It may even burst out the wall of a building if it strikes with sufficient force. An endless rope hanging free from a rapidly revolving wheel (Fig. 5) if deformed by a blow, will not return to its original shape. The kink will remain just as though the rope was made of metal and not rotating. These are instances within your experience and mine, where energy appears to have material properties.

P: I am willing to grant that energy may, as you say, masquerade as matter, but I do not agree that the moving baseball will weigh more.

R: I did not say that it would weigh more. I said that it had more mass. I think that you would find it difficult to send your scales hurtling after the baseball.

P: There should be other effects that could be observed. A fast-moving ball should exert greater gravitational force.

R: Now you are coming to something definite. I am ready to expound my theory of Mercury's orbit. When Mercury is nearest the sun it moves much faster than when far away, and, as its orbit is the most elliptical of all the planets, the variation of velocity is comparatively great. If its mass remains constant, as the law of gravitation supposes, the orbit should be a perfect ellipse. But if Mercury "weighs more" (to use your somewhat inaccurate expression) when it is going faster, gravitation will exert a greater tug* and the orbit will be a rosette, as observed. For planets other than Mercury the effect is too small to be observed. This is one triumph of relativity.

*Other causes also contribute—the variation of space and time intervals with velocity.

Real Significance of Relativity

P. What is the real significance of relativity?

R: Perhaps I can explain it best by analogy. Modern science holds the view that everything in nature is governed by law, contrary to the ancient superstitious belief in a thousand capricious gods. There are many such laws of nature, just as there are many laws on our statute books and the question arises:—Are they all independent? In the distant future, when mankind has developed sufficiently, it is quite possible that we may be able to discard the myriad statutes now on our books and substitute for them a single law—a sort of moral sense. So it is with science. Many physicists believe that all laws of nature may be put into one unifying principle. Relativity was a first attempt to do this, but Einstein's most recent paper (so widely adverised a few months ago) comes much nearer the ideal; unifying, as it does, gravitational and electrical phenomena.

P: You have proved that a great many things are relative*—space, time, motion and mass. How are these facts related to the theory itself? Is it correct to say that everything is relative?

R: By no means! There are certain things that are unquestionably absolute—number, for instance. Five beans would be five beans here, in China, or on Mars. We have seen how every attempt we have made to measure absolute motion has failed. The fundamental hypothesis of relativity is a generalization of this fact.

*See earlier articles for details.

By no experiment can we determine our absolute velocity through space. Some physicists would write it more briefly—All motion is relative.

P: Do you not make a second postulate to the effect that no object can move faster than light?

R: Yes, it is often stated that way, but it may be less confusing to put it thus: That no matter how high a velocity an object may have, when we measure it, we will never obtain a value greater than the speed of light.

P: Is that not practically what I said?

R: Yes, but my way of putting it immediately answers the objection of the person who says, "But I can easily conceive of a speed greater than light." I reply, "Conceive of it, if you desire; but when you go to measure it, you will find no higher velocity."

P: Why is the velocity of light so fundamental?

R: That, I cannot answer. Nevertheless, it appears again and again in various places where we least expect it—inside and outside the atom, in electrical and magnetic fields, in the radio set, in the burning of a piece of wood.

P: And relativity?

R: Einstein built up a theory of the universe that is consistent with these two hypotheses. Practically no one questions the accuracy of his mathematics; the only basis for criticizing the theory lies in the correctness of his two postulates. From Einstein's intricate calculations, emerge several predictions that can be tested by experiment, and it is upon the exactness of these that the theory must be judged.

Consequences of Einstein Theory

SOME of the necessary consequences of the theory are that no matter how we may attempt to measure the absolute speed of the earth through space, we shall get no conclusive result. This follows, of course, directly from postulate one. Then he predicts that a ray of light passing through a strong gravitational field will be "bent" or curved (Fig. 6). The light from a star, if the ray passes close to the edge of the sun, will thus appear to be deflected through a small, but quite appreciable, angle. Observations of the deflection can be made only at the time of total eclipse of the sun, when the moon covers the shining disk, so that stars can be photographed right up to its edge.

I already mentioned the fact that Einstein's theory demands the observed rosette form for Mercury's orbit, while the rest of the planet's orbits remain essentially elliptical. It is thus an improvement over the simpler law of gravitation.

Also, Einstein find that light emitted in any intense gravitational field should be slightly redder than light emitted in a weak field. These are concrete predictions, that can be tested by experiment. I haven't time now to discuss them in detail, but all have been verified.

P: But I still don't see how relativity accounts for gravitation.

R: Of course you will agree with me that there is no gravitational force in empty space. You will say that all bodies therin will move in straight lines. There, at once, is a difficulty because, as we already know,* straight lines are relative. What may appear straight to an observer on the earth, e.g., the path of a falling rock, will appear curved from the sun.

I avoid this difficulty by calling the path of the object a *geodesic*, instead of a straight

*See second article of this series.

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line, defining geodesic as the natural track that the body will take. Imagine a tightly stretched sheet of rubber. A small marble rolling on it will follow a natural path or *geodesic* which, in the older sense, is a straight line. Now put a heavy object in the center of the rubber so that the sheet is warped out of shape. No longer will the path of a marble be a "straight line," but it will still be a *geodesic*, for it continues to follow its natural path, curved this time because the surface on which it moves is curved.

"Curved" Space

P. I can't see how space, which is nothing, can be warped.

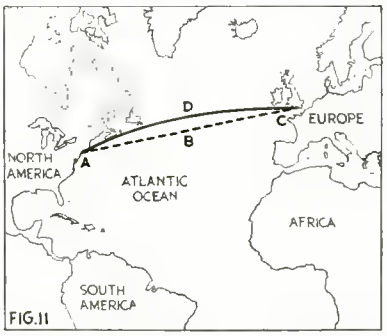
R: The phrase, "warped" or "curved" space, is not strictly accurate. The point is, that the curvature of space can only be detected when something material is sent into the region we wish to examine.

P: Wouldn't an ordinary magnet be an example of curved space then?

R: Yes, indeed, and you can't see the lines of force there, either, except when a piece of iron is put near the magnet.

P: How does the *force of gravity* arise then?

R: The *force of gravity* is an illusion. You think you detect it when you weigh an object. Suppose your scales are set in an elevator (Fig. 9) and that the pointer reads two pounds when the car is stationary. Now let the elevator fall freely under the force of gravity. The scale will swing back to zero and the object on the pan appears to weigh nothing.



The above illustration shows the lines drawn by the physicist and the relativist.

Here is an example that shows how the fourth dimension, time, enters into the problem. At this moment I put this box on that shelf. In other words, the box is located at a given point of space and time (Fig. 10). A quarter of a second later the box would strike the floor (at B) if the shelf did not prevent it. A—B is the natural path *in space and time*. A—C is the actual path. The box presses upon the shelf with a force that you call gravitation, but in reality the force arises because the box was made to deviate from its geodesic A—B. If it had traveled the path A—B there would have been no force.

P: I follow your reasoning, but if there is no force, why do not the planets move in straight lines?

R: Here is a map of the Atlantic Ocean. An airplane wishes to fly from New York to London in the shortest time possible.

(Physicist lays down a ruler and draws the line ABC.)

P: Along that straight line, of course.

R: No, he will follow a course something like this.

(Draws the curve ADC.)

P: Why? Are there storms driving him out of the straight path?

R: Note this carefully. You expected him to take the path ABC. I shall now give you the true explanation. You attempted to represent the earth on a flat map. ADC is actually the shortest path.

Introduce the *curvature of space and time* and the force vanishes. Gravitation is an illusion.

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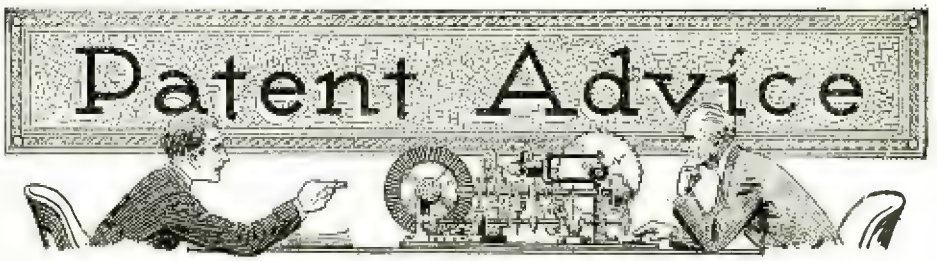

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NOTE:—Before mailing your letter to this department, see to it that your name and address are upon the letter and envelope as well. Many letters are returned to us because either the name of the inquirer or his address is incorrectly given.

Crumb Sweeper

(1170) Barney Mason, Retsil, Wash., asks if a crumb sweeper made like a carpet sweeper would be a good thing to work upon. He also wants our opinion as to the merits of an electrical shoe shiner and a baby carriage brake that will be applied when the handle bar of carriage is released. The nature of none of these ideas is disclosed.

A. The crumb sweeper which you have designed is very old and is procurable on the American market today. The principle upon which it operates is incidentally the same as the one you have designed and, being made of silver, it presents a very neat appearance. We doubt very much if you can secure a patent on yours.

With reference to shoe shiners, and brakes for baby carriages, we would advise that either of this ideas might make a fortune for the inventor who designs the right one and exploits it properly.

Airplane

(1171) Wallace Nordvall, Duluth, Minn., enters a diagram of an airplane on which he would like information. This is equipped with a double propeller on either side of the fuselage and driven by a common motor through gears. The propellers are housed in tunnel-like structures on the wings.

A. We do not believe that you could get a patent on placing a series of propellers, one in back of the other, and driving those propellers from the same motor shaft. As far as gearing up the motor is concerned, we would advise that as speed increases, slippage increases and pitch of the propeller must be considerably lessened, therefore your device would not produce a plane speedier than any other. Increase of speed does not necessarily mean increase of power.

Neither is placing the propellers in a tunnel-like structure of value. It has been definitely proven in experiments both in air and water, that housing the propellers lessens efficiency because of friction of column of fluid against the sides of the confining air chamber.

Your type of plane, therefore, is not as good as those in existence today and consequently we would advise no action.

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Flue Damper

(1172) George C. Orr, Detroit, Mich., sends us a diagram of a flue damper which is made in two half portions and points out what he calls advantages. These are made clear in the answer. He asks our opinion.

A. We are answering your questions in order, on the smoke pipe damper:

1. You state that your smoke pipe damper prevents the escape of hot gases, formerly lost through the hole in the ordinary type of damper. You do not explain why this is so, nor does your diagram indicate this. The slight circuitous route making the gases travel further does not extract all of the heat from the gases. Furthermore, these gases are not as hot as you imagine them to be, otherwise they would have delivered their heat in the fire pit.

2. There is nothing unusual in a fire burning all night. This writer has had a fire going since Oct. 4 and has had no difficulty in holding it. The old style damper has been used. Thousands of other furnaces are also doing the same.

3. Gas explosions are very rare occurrences. There is no reason why your damper should prevent explosions more than any other damper.

4. You mention an appreciable and worthwhile saving in fuel, but we see no reason for such a statement and you do not say why.

5. You say that your system is absolutely foolproof because it is impossible to close the smoke pipe entirely. This same is true of the present style of dampers. The only factor which we can see in your smoke pipe damper is that you must use two controls instead of one to regulate the draft and in that way you might get a better regulation, but we doubt it.

We frankly can see no reason for applying for a patent on your system.

Fire Extinguisher

(1173) Paul K. Chapple, Ashland, Wis., has suggested a fire extinguisher in the form of a glass bottle containing acid, a bicarbonate of soda solution and an explosive for breaking the container.

A. If acid is released into a thin glass bomb containing sodium bicarbonate dissolved in water, the pressure generated within this container will burst the container. There is no need for the nitro-glycerine capsule. Furthermore, nitro-glycerine will not explode when it is handled as you describe, and when properly set off such an explosion is not only dangerous, but also non-efficient. There is no reason why the fluid should be scattered against the ceiling.

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Space, Time and Relativity

By Donald H. Menzel, Ph. D.

(Concluded from May Issue)

R: Your calculation will be correct only if the Earth and Mars are absolutely stationary in space. If we are moving, the light may have had to chase after us, like a man after a street car, or we may have gone some distance toward meeting it. We know that the sun and planets are moving together through cosmic space. We are always able to distinguish our *velocity, relative to some object*, but it is practically impossible to define absolute velocity, let alone determine it.

"Ether Wind"

PHYSICISTS of the nineteenth century were confident of the "ether" which was supposed to be a vast, stationary sea of "something or other," through which the planets travelled without friction, and which transmitted waves of light like ripples on a stagnant pond. This hypothetical, non-material "something or other," the stationary ether, is the nearest we have ever come to the absolute. Just as the velocity of a ship relative to the ocean has a perfectly definite meaning, so the velocity of the earth relative to the ether would have a meaning, *if it could be determined.*

Carefully executed experiments have failed to detect this wind and, consequently, the earth's absolute velocity.

If we cannot determine our absolute velocity, we are unable to solve the problem as to when the signal was sent from Mars.

L: I don't see just how you draw that conclusion.

R: Let me give a demonstration. There is a train standing still on that track just a mile away. Now, ready with a stop watch: I start it when I see the steam coming from the whistle and stop it when I hear the noise.

P: It takes four and two-fifths seconds for sound to travel a mile, which should be the time registered by your stop watch.

R: You are wrong. I find a value of four and three-quarter seconds.

P: (After looking out of window.) There is a terrific wind blowing away from us. That will slow down the sound.

R: I think you are reasoning in a circle again. We were trying to calculate the time the sound left the whistle.

P: I could find the speed of the wind by an anemometer, a windmill, or a whirligig.

R: But what if every such wind gauge you could construct failed to register the breeze?

P: That would prove that there was no breeze.

R: Suppose you ran up and down with the wind gauge. If it still did not detect a wind what would you think?

P: Probably that all the forces of nature had conspired against my finding the velocity.

R: Exactly. But such failure to measure the wind velocity means that you will be unable to calculate the exact time that the whistle was blown.

P: That is true. Nevertheless, failure of the gauge is only hypothetical.

R: I only used sound waves in air as an analogy to light waves in the ether. Experiment proves that we cannot determine the absolute velocity of the earth—its speed with respect to the ether.

We tried to calculate the time that the Martian flashed the signal but failed. Our experiments prove that there is no such thing as *simultaneous* events in different places.

L: Isn't that rather extreme? You have merely proved that we are unable to determine whether two events widely separated in space are simultaneous or not.

R: It amounts to the same thing in the long run.

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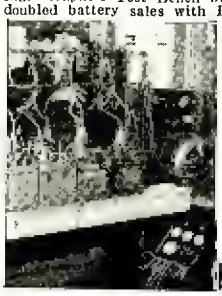

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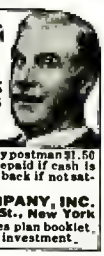

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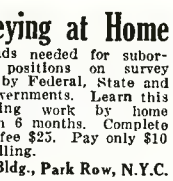

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Making An Exponential Horn

By Ernest Romkee

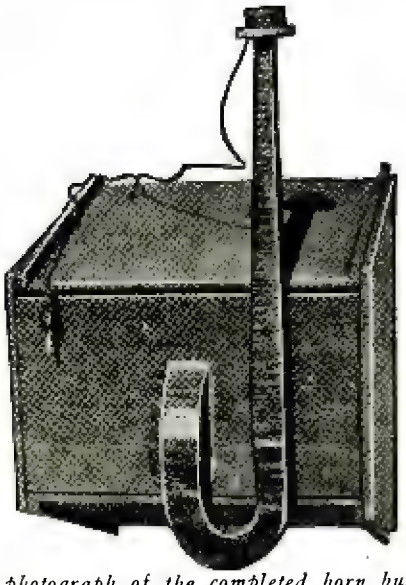
(*Continued from page* 154)

glue, the two finished parts may be joined. Use 3d nails wherever possible as this makes the assembly much stronger than glue alone.

After the piece E is finished and the cement hardened, cut or saw an opening in the center for the small throat of the horn as it must go through this to connect with the opening at the rear of the blocks A which are now in place. Fasten the part E in its proper place and you are ready to make the end of the horn

Small End

WE now have in our large part of the horn an air column somewhere near 47½ inches long which leaves 30½ inches as the length for the small end. The shape of this part of the horn is determined by the shape and size of the cabinet and also the desired location of the reproducing unit. The inside dimensions of this are 3⅜ x 2¼ inches



A photograph of the completed horn built by the author is shown above.

and should taper to ¾-inch square where the unit fits. While it is not absolutely essential, it is well that the rate of expansion of this be in the same ratio as the rest of the speaker. The shape has nothing to do with the size, but if any bends are made, as no doubt there will be, it is well to make careful measurements. A good idea of this may be had by looking at the photo.

After the four pieces of *Beaver Board*, of which this part is made, are fastened together with brads and glue and the glue has had time to set, the whole length is wrapped with two layers of friction tape wound on as tightly and evenly as possible. This is to thicken the walls to deaden any vibration and also makes it a great deal stronger than it would be without this wrapping. The inside and outside of the finished part should be given a coat of shellac. The inside may best be shellacked by stopping the small end and pouring a quantity of shellac in and turning it round and round and rocking back and forth so that every bit of surface will be covered.

A piece of sheet metal about two inches long is next shaped to fit inside the small end and the reproducing unit connected with the usual soft rubber connector.

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Regular reading of the advertisements is one of the essentials of good housekeeping.

Any openings that might be left around the tail of the horn where it goes through the part E should be carefully and tightly filled so that there will be no chance for vibration and no air leakage as either would be detrimental to the tone of the horn.

In mounting the horn in a cabinet, heavy felt or rubber pads should be used at all points of contact for best results.

When the horn is all finished both inside and outside should be given one coat of thin flat black paint. In addition to making it proof against moisture, it improves the appearance a great deal, and a black interior will not show through the grill cloth.

For best results a unit of the balanced armature type should be used, but any other gives results superior to ninety per cent of the loud speakers on the market. With a good audio amplifier, the reproduction is so nearly perfect that when one is in a room some distance from the loud speaker it is often hard to distinguish between it and music played in the house.

The total cost of the speaker, not counting labor, will not exceed $6.00. Of course this does not include the speaker unit. One of the balanced armature type of the best grade will cost between eight and ten dollars, making a total cost of not over $16.00 for a speaker second to none.

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Power Plants Heat River Which May Warm City

(*Continued from page* 115)

doubt but that city air temperature is above that of the suburban sections but a short distance from the city. Some engineers have stated that the East River does not freeze over, for the reason that this hot water is being constantly poured into it, but then again, there are very few people that can remember when the East River did freeze over, even long before power plants were installed along this water front.

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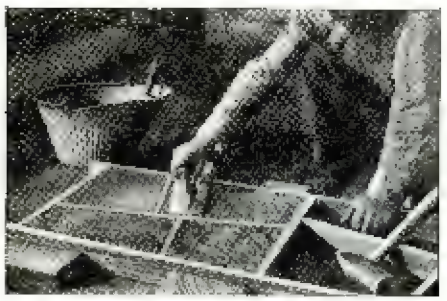
Making Your Own Cement Walk

By H. L Weatherby and P. P. B. Brooks

(*Continued from page* 128)



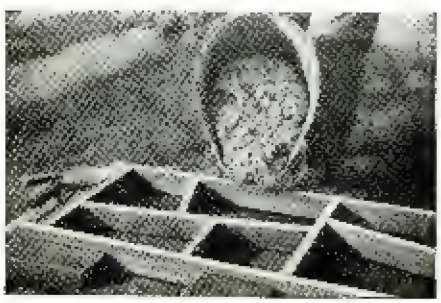
The trowel is worked along the sides of the forms to obtain a close contact.

know that if a rather thick layer of glue hardens between two pieces of wood you get a poor joint, because the glue is used as a tough adhesive, while we draw the pieces together with a clamp so that there is only a very thin film of glue between the pieces with glue filling the pores of the wood, the wood will often break at some other place than at the joint. Very much the same principle governs the use of Portland cement. The spaces between the larger pieces of gravel are occupied by the smaller pieces and the spaces between the smaller pieces are occupied by grains of sand. These spaces are called *voids*. The coarse gravel, fine gravel, and sand should be proportioned so as to reduce the voids to the least amount possible. The cement then serves two purposes. It fills the remaining voids and it forms a thin adhesive film over every piece of gravel and grain of sand which, when it hardens, binds the mass into one solid stone. You see that *for the best results, gravel, sand, cement, and water should be accurately proportioned.* Furthermore, the mass should be kept damp so that none of the water which is needed by the cement will be lost by evaporation before the setting process, which proceeds slowly, has had time to reach completion."

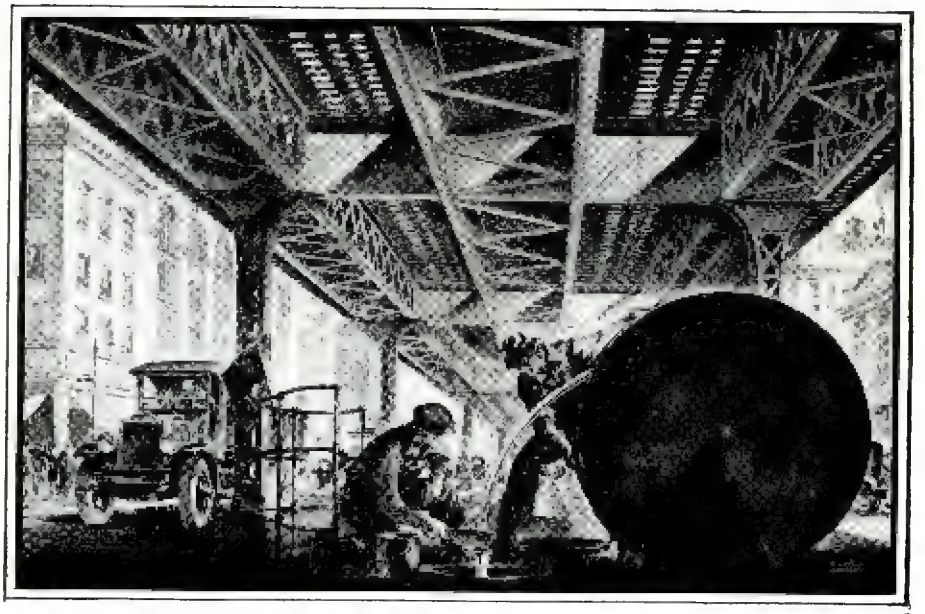
Use of Sand and Gravel

"ONCE I saw them using crushed stone instead of gravel to make concrete," said Willie.

"Yes," said Mr. Brown, "the sand and gravel are called the *aggregate*. The sand is the *fine aggregate* and the gravel the *coarse aggregate*. Crushed stone makes a very good coarse aggregate when it is cheaper than gravel. Its rough surfaces, however, serve to increase the voids, thus requiring more cement, making the concrete somewhat weaker than it would be if made from good gravel and more expensive when gravel is readily available. The sand should



A coal scuttle is excellent for pouring the mixture. Note stiffness of mortar.



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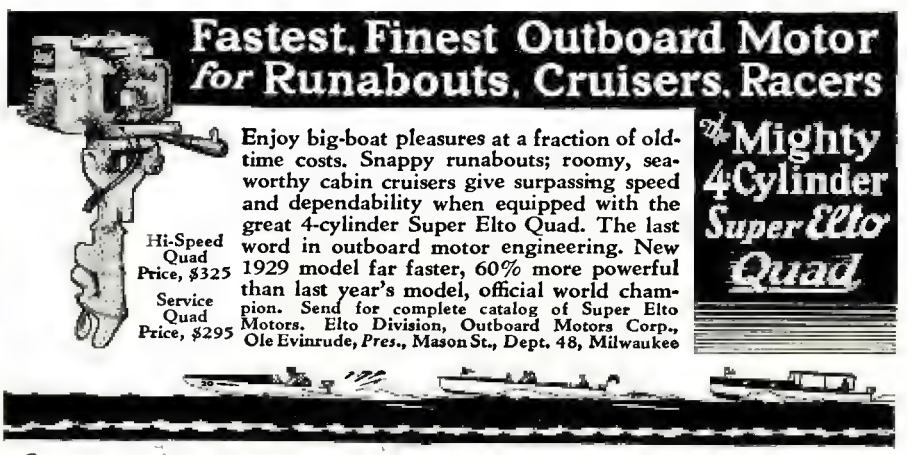
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be clean and hard, not necessarily sharp as many people suppose. It should be free from clay, soil, and organic matter as rotten leaves, roots, etc. are called."

"You know so much about concrete, I don't see why you don't make those stepping stones for the back yard, I have been wanting so long," said Mrs. Brown.

Question of Tools

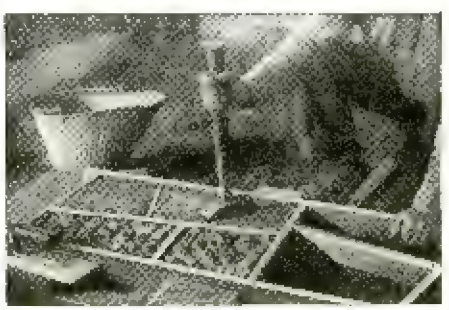
"WELL, I have no tools for concrete. Then I would have to buy a load of gravel and a load of sand, which is more aggregate than I need and would cost more than the blocks are worth," replied Brown.

"You have those old plastering trowels in the garage and anyway a trowel does not cost much. You can mix the stuff with a shovel and a hoe on the concrete floor of the garage. As for the aggregate, as you call it, why can't you use those cinders from the furnace?"

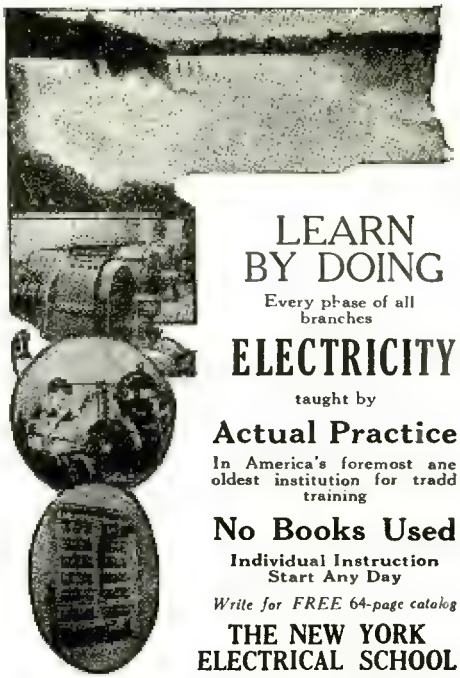
"Well, Mr. B. *a concrete is no stronger than the aggregate from which it is made.* Cinders are used sometimes for large masses that do not have to carry much load or stand much wear. But house cinders are too full of ashes to be of any value."

"Well, there is plenty of gravel along the creek where we eat our picnic lunches Sundays and holidays. We can put a box on the car, take a coal shovel and scuttle, and haul back each trip a boxful of gravel which will cost you nothing."

"That is bank run gravel. Nature does not usually mix sand and gravel in the right proportions for concrete. It would have to be screened and remixed. I have no screen. Undoubtedly, too, that gravel contains a lot of humus and organic matter. I would have to fix up a device to wash it.



Thorough packing of the mortar in the forms is important. This process is illustrated in the above photograph.



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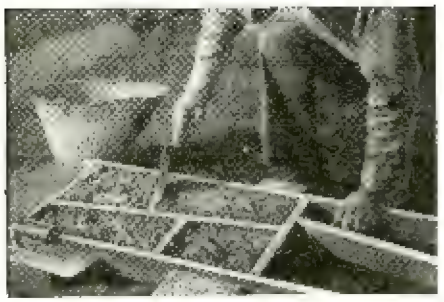


The upper surface of the concrete is worked with a trowel until it becomes smooth.

It would be cheaper to buy the blocks. But even if that gravel is all right, I have had no practical experience. I would make a mess of it. Why even a half gallon of water too much to each bag of cement used would weaken the concrete nearly 400 pounds. In the size batch that I should mix just a pint too much water might ruin it."

"What do you mean by weakening it so many pounds? These blocks are to lie flat on the ground and the only load they will carry is a person's weight when he steps on them."

Effect of Too Much Water

"THAT is just what I mean." said Mr. Brown. "Good concrete should carry over 2700 pounds to the square inch. That is called its compression strength. One-half gallon too much water in a one bag batch, or about five cubic feet of concrete, weakens the concrete nearly 400 pounds per square inch."

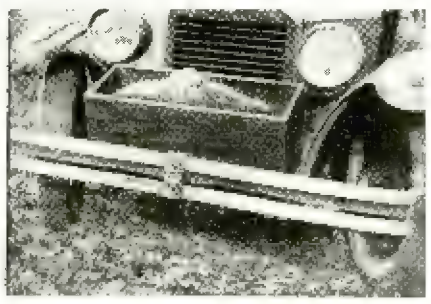
"And suppose you were so stupid as to use twice as much water as needed?"

"Then instead of 2700 pounds the concrete could support only a little over 800 pounds per square inch."

"How awful!" said Mrs. Brown. "Then a block fifteen inches long and eight inches wide would be able to hold only forty-eight tons."

"Yes," feebly, after a moment's thought.

"Well, we are going to try that bank run gravel and I promise faithfully that I and



Small quantities of gravel can be hauled conveniently on a car. The box shown above holds about one cubic foot.

the children will never step as hard as 800 pounds on any square inch of any block. You have a half day off tomorrow. When you get home at noon, the children and I will be ready with the lunch, and if you won't get the gravel, the children and I shall."

Mr. Brown knew his concrete—theoretically. His books were not at fault, except that they were written for the concrete worker rather than for the handy man about the home. They emphasized best methods and most efficient tools to secure economy on the large job and maximum strength and endurance. Mr. Brown did not realize that with the tools that he had, with gravel from the bank or creek just as he found it, he could make most of the concrete that he needed. Concrete does not need to have a compression strength of nearly a ton and a

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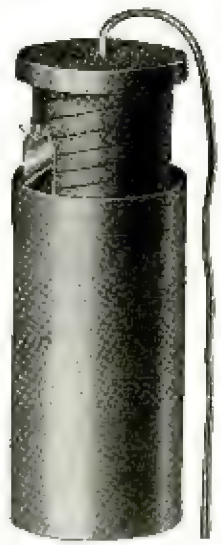

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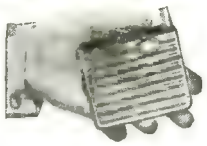

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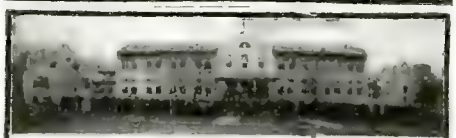

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half to the square inch to be practical and permanent in much home work. At noon the next day he brought home a bag of cement and some lumber for the forms.

Getting Down to Business

THE remainder of our story can be read largely in the pictures. The reader will observe that the tools used are common to the home. The forms were made from two pieces of dressed lumber about six feet long and two and one half inches wide, spaced fifteen inches apart, with cross pieces forming both irregular and rectangular divisions for the blocks. The rectangular divisions were 15 in. x 8 in. Mrs. Brown said that the irregular blocks would have more the appearance of natural stone.

Before the mortar was poured, the forms were greased with crank case draining so that the concrete would not adhere to the forms and the forms would not absorb water from the mortar. The platform on which the form rested was made from old rough lumber.

Mr. Brown measured his gravel with the bucket when he unloaded the box. He measured out, as nearly as he could, one fourth as much cement. This he distributed evenly over the gravel which had been spread on the garage floor. Then he worked the two together until the mass was a uniform gray in color. As the gravel from the creek bed was wet, it was useless to try to measure the water. With the sprinkling can, he

The above photograph shows how the strength of a concrete block is tested with a car.

thoroughly wet the mixture which had been spread out again in a thin layer. Then he worked the mass thoroughly, adding a little water from time to time and continuing to push and pull the mass back and forth with the hoe until a stiff mortar, evenly wet through and through, was obtained.

The mortar was poured into the forms from the bucket, and spread with the trowel. The trowel was worked back and forth and up and down along the sides of the form to bring the mortar into intimate contact with the sides and to work the coarser gravel away to allow the sand and cement to form a smoother surface. A heavy hammer served as a tamper to compact the mass. Thorough packing is essential and the tamping also forces the larger particles down making a smoother surface possible. Finally the surface was smoothed with a trowel.

After the cement had got its first set, it was covered with burlap sacks to retain moisture and the heat produced during the setting process. Twice a day the burlap was sprinkled. The blocks were allowed to

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cure in the forms for about a week, mainly for the reason that the maker had not the time to remove them sooner. Twenty-four to forty-eight hours would have been adequate. The slow curing in the forms under the damp burlap, however, added materially to their strength.

Testing Concrete

MR. BROWN made a test on one of his blocks two weeks after the mortar was poured. The block, 15 in. x 8 in. x 2½ in., supported at the ends on two bricks, held the load carried by one rear wheel of his car. The test shows that the blocks have plenty of reserve strength for the purpose intended. No tests were made to find the breaking load.

In making an estimate of the cost of these blocks, we shall consider only the actual cash outlay. As the bottom boards of the form were old lumber and could have been dispensed with anyway by putting the form on the sidewalk, the forms did not cost over fifty cents. When this cost is distributed over the entire lot of blocks to be made it will be insignificant. At 70 cents a sack for cement, the concrete cost about 18.3 cents per cubic foot or a little less than four cents per square foot for concrete 2½ inches thick. As distributed in the walk, the cost was about 3 cents per lineal foot.

It is not our idea that the reader will now rush to his back yard to make concrete stepping stones. We have chosen this subject for our introduction because we have available in this connection adequate data for showing the simplicity and economy of concrete construction about the home and for developing in your mind some of the finer points of good theory and practice. Perhaps the reader has consulted some of the textbooks and has been restrained from making his first attempt by some of the details which stood in Mr. Brown's way, while, as a matter of fact, he has all of the essential tools, with the possible exception of a trowel, and there is an available supply of sand and gravel which will cost him little or nothing. On the other hand, there are few other processes which permit of as much latitude in the handling as the mixing and moulding of concrete. You can violate half the rules in the texts within rather wide limits, and yet, if you thoroughly mix your mortar and tamp it well into the forms, you will secure a concrete strong enough for many purposes around the home.

The reader will discover for himself numerous applications of concrete which present no more difficulties than the stepping stones.

House Plans You Can Read

By J. E. Lovett

(*Continued from page* 126)

accommodation and arrangement of the rooms, the windows, and special features are matters which must be decided firstly by the client, and when incorporated in sketch plans it is very necessary that he should be enabled to see whether they are provided to his complete satisfaction. It is certainly easier to rub out a few lines of a drawing than to demolish a few walls of the structure itself.

The sketch plan, which forms the basis of working drawing, can be best "read" by the layman by presenting it in a distorted isometric arrangement converting it to third or cubic dimension by including depths. Thus on plan the horizontal lines would be the "breadths," the slope lines (at 60 degrees) would be the "lengths" and the vertical lines (ordinarily) "lengths" would be the "depths." This converts the plain plan into a sort of "perspective" plan is that it is readable in perspective. An important feature of the "perspective plan" is that it is readable in both senses of the word, that is, from observation and scaling. The depths convert the plan into a sectional view, and the walls, openings, etc., can be scaled in length, breadth and depth. This does not apply to the true perspective, which is only true to proportion but not to scale.

To anyone accustomed to preparing isometric projection, the "modus operandi" has probably already been grasped from the illustrations. This system of drawing sketch plans is quite simple, and merely requires the setting out of the plan as usual, but with the return walls at an angle of 60 degrees instead of 90 degrees. All breadths are drawn with the tee-square, as for the usual sketch plan, but all lengths are to be set out with the 60 degrees set-square.

The plan is first drawn without the depth lines and obviously after the plan has been worked out and the arrangement of rooms decided. The base line is the front wall of the building, and at each end the return walls are drawn at an angle of 60 degrees to the horizontal. All lengths should be marked along the slope lines, and not from horizontal line to horizontal line. The breadths should be set out as usual. The position of openings, such as doors, windows, and also partitions or set-backs, are thus set either along the slope or the horizontal lines, and the plan is completed. Sills, steps, paths, or any exterior projections or attachments should not yet be drawn on. When the depths are set out it will be seen that such features occupy a different position.

The plan when completed and ready for marking on the depths, appears just like an ordinary plan which has been squeezed "out of square." Drawing No. 1 indicates such a plan, and is a sketch of a bungalow, ready for converting into a "perspective" sketch plan.

A short vertical line is then dropped from the front quoin, and the height or rather depth of the section is decided. It is not advisable to make this more than 4 feet, which will allow about 3 feet 6 inches of the internal walls, etc., to be shown. The ground line should then be continued on the return, and vertical lines dropped from every junction of slope lines with breadth lines, and from window openings, doors, etc. The internal floor level is marked on and returned round the rooms, and the internal features are marked on. Steps and wall projections should be set out from the point of junction between vertical lines and either of the others. Doors and casement windows can be shown either open or shut, and tiled floors or boards can be marked on. Hearths are marked on at the junction of breadth with floor lines. There are no vanishing points whatsoever. Drawing No. 2 shows the completed sketch plan of a bungalow. Measurements can be read from these plans in the same manner as they are drawn out, and obviously to the same scale. Lengths should be read along the slope lines, breadths along the horizontal lines, and depths from any horizontal line to ground line.

This type of sketch plan should dispense with any suspicion of misunderstanding between the parties concerned with the construction of a building, and the client will be unable to plead ignorance of technicalities when the proposed structure is presented to him in a manner which would permit a child to understand.

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Moving Mechanisms Appear Stationary by Flicker Light

By Philip Dawson

(*Continued from page 129*)

Imagine a rapidly rotating wheel with a conspicuous mark at one point on its circumference, now suppose it were possible to blink your eye at the same speed as the wheel revolutions so that it was open for a brief instant just as the conspicuous mark reached the top of the circumference, the impression your eye would receive would be of a wheel standing perfectly still with a conspicuous mark at the top of it.

Since it is impossible to execute such tricks with the eye, the stroboscope provides a mechanical means of interrupting the observer's vision in exactly the same way.

Stroboscopes are divided into two distinct types, interrupted vision and direct vision, and there are a number of variations of each type.

In the interrupted vision type the observer looks through an oscillating or rotating shutter which interrupts his vision in synchronism with the movement of the machine under observation, and in the direct vision type the moving machine is viewed under the rays of a flashing light which flashes in synchronism with its movement.

Simple Stroboscopes for the Experimenter

IMAGINE the thrill of being able to see just exactly what the parts of a device you have constructed are doing when running at full speed.

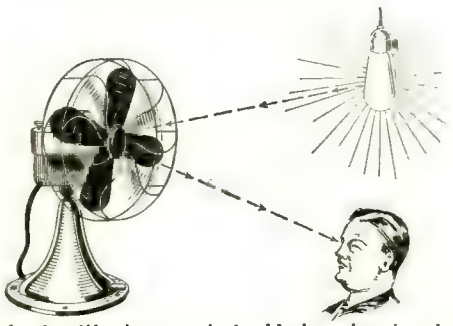
You will probably be greatly surprised when you see the tricks played by inertia, the strange ways in which springs vibrate, the way apparently rigid parts will bend and twist, and the curious flow of the lubricant on running surfaces.

Yet all these and more may be comfortably observed with a stroboscope constructed with very little effort.

The writer has had wide experience in the field of stroboscopic research, and there have been innumerable occasions when information obtained in a few minutes of observation have been the means of solving problems of years' standing.

Figs. 1 and 2 illustrate two methods of constructing simple stroboscopes which will work quite well.

The electric motor MB is controlled by a variable resistance R so that the speed can be varied until it synchronizes with the speed of the machine under observation.



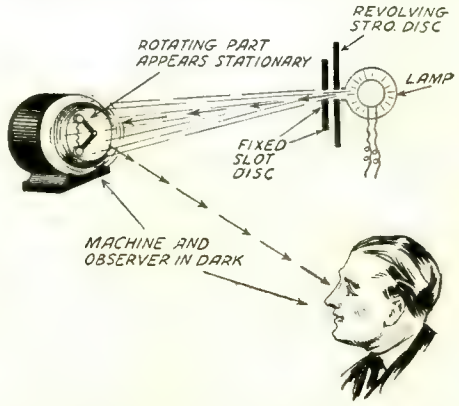
A ghostlike image of the blades of a fan is often seen and appears to be traveling slowly. This is produced because the A.C. lights in the same room are flickering slightly out of synchronism with the fan motion.

D is a disc made of cardboard, bakelite or any suitable material in Fig. 1, and in Fig. 2 a piece of tube is used instead.

The disc has a slot S cut in it as shown, or if the tube is used two axial slots are cut diametrically opposite to one another.

A screen B is so placed that its aperture A registers with slot S once per revolution.

Now if the observer looks through the aperture A he will get a quick glimpse of the machine under observation, once per revolution of the disc D, and if the motor M is then regulated until its speed synchronizes with that of the machine under observation, it will then be seen for a brief instant at the same point in each revolution and consequently *it will appear stationary.*



The above illustration shows how the electric flash stroboscope works. This work is carried out in a dark room.

The exact construction of the stroboscope has not been described in detail, because the experimenter who rigs it up will like to exercise his own ingenuity in such a matter, and the construction will probably partly depend on the materials he has on hand.

A little experimentation will have to be done with the width of the slot S, since it will be a matter of suiting the problem to which the device is being applied.

The narrower the slot is made the clearer will be the details of the moving parts, but they will not appear so brightly illuminated. If, on the other hand, the slot is made too wide, the details will appear blurred but well illuminated.

It is therefore best to make a suitable compromise between brightness and clear definition.

This is a simple matter because a piece of paper can be placed over the slot to make it narrower.

If a battery-driven motor is available this is better than a universal motor running off the lighting mains, because variation of line voltage will cause variations of speed, and it will be necessary to regulate the motor frequently to keep it in step.

It is essential that the moving machine should be illuminated with a powerful lamp while using the stroboscope.

If the disc as in Fig. 1 is employed, it will be necessary to drill a hole on the opposite side to the slot to counterbalance it, otherwise the vibration will be so great that it will be impossible to keep the motor still. This hole can be placed close to the center so that it does not show through aperture A.

The tube type shown in Fig. 2 is really preferable to the disc type because a wider slot can be used.

The Direct Vision Stroboscope

IF instead of looking through aperture A, you shine a powerful light through it which will fall on the moving machine once per revolution, you will have a direct vision stroboscope, but you will have to work in a dark room or in some way screen the machine so that outside light will not fall on it.

This is worth trying and you might find it better for your purpose.

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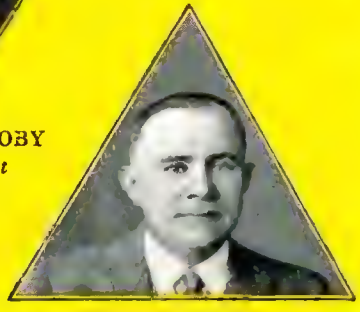

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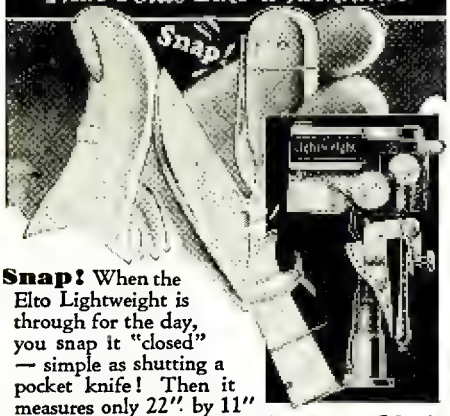

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A Radio Fish Screen

By S. R. Winters

(*Continued from page* 153)

one and a third volts, per inch, minimum, and two maximum. The average length of the fish was three inches. These values checked the 60-cycle alternating-current tests very well, as shown by the maximum and minimum curves."

To paralyze and at the same time not to electrocute the fish was the problem, keenly recognized by these investigators. In reality there were as many as eight problems involved in the tests. What uniform voltage will cause fish to become paralyzed, and does this voltage vary with the length of the fish? How does the accepted unit of voltage and duration of application affect the life of fish when subjected to excessive currents? Do fish thus treated with high-frequency or radio currents suffer ill effects not discernible at the period of treatment? What are the resistance values of different bodies of water and to what extent are these barriers in failing to produce paralysis in fish? Are fish, swimming in this radio or electric field, sensitive to the direction of danger? Does the relation of the lines of electric-current flow and the equipotential surfaces, with respect to the opening protected and the direction of water flow in the stream, have any influence on the effectiveness of the screen? And, will a radio screen prevent fish entering a protected area?

The high-frequency or radio current applied to fish had to be sufficiently strong to cause the finny trible to lose all control of movement, if the object of the tests was to be realized. The aquarium employed had glass sides, wooden bottom, and the ends were fitted with two parallel metal plates. The area of the latter was commensurate with the cross-section of the aquarium. The parallel metal plates were associated with the terminals of an insulating transformer; the latter was a form of insurance against current leakage to the ground from one of the plates, due to the grounded side of the lighting line. The applied voltage was varied from zero to maximum predetermined values by the use of a potentiometer, which controlled the amount of current going to the primary of the insulating transformer. This set-up of parallel plates, with a variable voltage supply, rendered it possible to obtain a uniform voltage gradient, in the fish hatchery, of any desired value. The tests, in the main, were confined to 60-cycle alternating current.

"The method of determining the paralysis voltage," points out Professor McMillan, "was to place a number of fish selected for uniformity of size in the aquarium between the parallel plates and raise the voltage in small amounts, holding each increased value one minute. When the first fish became paralyzed, the plate voltage was recorded as the minimum paralysis voltage. The increase in voltage was continued until all the fish were paralyzed and the plate voltage again recorded, this time as the maximum paralysis voltage.

"From these voltages and the known plate spacing the minimum and maximum voltage-gradients per inch to produce paralysis were calculated. The lengths (in inches) of the fish used in the experiment were then measured carefully from the tip of the snout to the end of the middle rays of the tail fin. The average length of the test group was calculated and recorded; these tests were repeated on many fish ranging in length

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from 1.87 to 31.75 inches. These data bring out two very interesting facts. First, the voltage gradient required to produce paralysis is very low. Second, the voltage-gradient required to produce paralysis decreases as the length of the fish increases. In other words, the long fish require a much lower field strength to paralyze them than the short ones do. This is the opposite of the conception held by many previous to these tests."

Naturally, the duration of the applied voltage has an appreciable effect upon the mortality of fish. For instance: a voltage-gradient of 1.48 volts a minute paralyzed 26 of the 30 fish in one minute without sacrificing a single life, and yet when practically the same voltage was applied for a longer time all of the fish were paralyzed and after a five-minute dose of radio-frequency currents 69 per cent. of the fish succumbed. The length of the period of complete paralysis or "suspended animation" appeared in every case to be the greatest factor in determining recovery from electric shock. Virtually, without exception, it was observed that when a group of fish were shocked the fish paralyzed first were last to recover and those paralyzed last were first to recover.

Curiously enough, the radio fan who has sustained a short-circuit in his receiving set will want to know the behavior of the "poor fish" under like circumstances! A short-circuit of several hours' duration, attributed to a poorly-insulated scrap of wire, removed the voltage from the radio screen and between 3,000 and 4,000 fish invaded the protected area. However, they were coaxed by food from this region before the screen was electrified again. This short-circuit proved that: first, it is essential to maintain a reliable source of supply; and, second, the screen was effectively barring the fish from the protected area. The number of fish killed by the radio screen during an eleven-day test was surprisingly small—only 29 were electrocuted, or one-fifth of one per cent, of the 15,000 fish in the test pond.

The factors entering into the design of radio screens are eight-fold, if we are to accept the conditions outlined by the Bureau of Fisheries. An insulating transformer should be employed between the power supply and the screen, thus avoiding a needless flow of current from the electrodes to the ground; the lines of current-flow in the electric field must be perpendicular to the plane of the protecting opening and the equi-potential surfaces parallel with this plane; the lines of electric-current flow must be parallel with the direction of the water flow; the voltage-gradient in the electric field should be kept as uniform as practical by the selection of proper electrode sizes and spacing; the voltage-gradient must be suitable for the size of fish to be protected; the spacing between electrodes in the rows is determined largely by the opening desired for debris to pass through; the spacing between rows of electrodes should be approximately one and a third times the spacing of the electrodes in the rows; and the electrodes should be from two to twelve inches above the bottom of the stream—the distance depending upon the spacing of the electrodes and upon the character of the stream bed.

This strange adventure—that of employing radio waves as guardians for millions of fish that otherwise would stray from their true feeding grounds—is imbued with sound engineering principles, namely: there is a relation between the minimum voltage gradient necessary to paralyze fish and their length; the mortality of the finny tribe subjected to radio treatment increases with the duration of the application of the current; electric shocks, strangely enough, do little harm unless they kill outright; the electrical resistance of the water has a bearing on the necessary voltage required to paralyze fish (for instance, one river has a resistance to radio waves 880 times greater than that of sea water); fish swimming in a sea of radio currents have a sense of the direction of the danger and attempt to steer away from the pitfall; and finally, the experimental radio fish-screen is a pronounced success.

The Coast and Geodetic Survey has indicted the noisy oyster because of interference with underwater radio reception; the Bureau of Fisheries embraces radio waves as a protector of errant fish.

How to Build Your Own Airplane

By George A. Gerber

(*Continued from page* 141)

correct position as illustrated.

The first taxi proved to me that this plane would fly: so "we" hired a pilot to test hop it. It proved to be a flying fool,—nice balance—stable and easy to fly,—as was evidenced by my partner's solo in one hour and 45 minutes of dual instruction in it, while I followed on one hour and 55 minutes.

It makes a wonderful dual instruction job, and if this article proves interest to be keen enough, I will prepare detailed data, if you will state your desires to the Editor.

The test pilot, formerly of Elgin, now at Municipal Field, Chicago, flew the "bus" to Elgin. We followed, he instructed us in our own job, and we went to barnstorming ten hours after our solo, and to date I have close to 200 hours without an accident, and while this is nothing extraordinary in itself, my flights have not been continuously consecutive, as I have given most of my time to building, and what flying I have done has been of experimental nature—mostly test hops of newly built planes—some of unusual design.

I am not licensed for that same reason, that I do not put in enough time consecutively to hold one. Sort of free-lance.

Of late I do just enough flying to keep in A-1 shape, and use plenty of horse sense.

The ship I am giving the data on is my fourth, and here we will have a short discussion on biplane versus monoplane.

Both types have their virtues and their vices, and it would be very hard to state which is the better, as each fills certain needs better than the other.

For instance, the OX5 Standard J-1 lands so slowly in a moderate breeze a person can run alongside; and the same in taking off; and once in the air its top speed is not more than 65 m.p.h.

That would be fine for training, but like the Jenny or Canuck, it will stall and spin, though slower to do so, than either of the others, in my estimation.

The Jenny and Canuck are a little faster, with a top speed of between 70 and 75 m.p.h. (These figures are air speed.)

Many of the new production biplanes have been pepped up to a top speed of 100 m.p.h. and over, with an OX5 engine, but still are no equal for the monoplane with same power and load.

The chief disadvantage of the monoplane is its fast landing speed, which is usually termed "hot."

Most of the commercial jobs range from 45 to 49 and even 52 m.p.h. in the hands of an expert pilot, while in the hands of a novice, the landing speed often runs up to 60 and 65 m.p.h.

A compromise in a training monoplane is a job loaded light per square foot of wing area about 6 to 6½ pounds per square foot in a high lift airfoil, thus reducing the landing speed to approximately 30 to 35 m.p.h. at the most, and due to the elimination of bay struts and rigging cables, air resistance

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is lowered in a monoplane of this type to such an extent that even a job with a landing speed of 30 m.p.h. will have a high speed close to 90 m.p.h., at a power loading of 20 pounds per horsepower, with the correct propeller revolutions and pitch.

The monoplane is advantageous when used as a training ship in the following ways:

Mainly, visibility, which affords the pilot a perfectly unobstructed view directly below, in an open job. Also the landing gear (wheels) are visible.

Perhaps rating first, should be *stability*.

The parasol type monoplane correctly built is, I believe, the most inherently stable airplane yet developed.

"Our" two-place instruction job has flown completely without pilot's guidance for 30 minutes at a time. and in bumpy weather it seemd to fly itself better when let alone than when controlled, by this I mean the dampening effects on bumps. Undesirable oscillation was conspicuous by its absence.

Regarding the stall, the cause of fully 90 per cent of airplane accidents, due mainly to two reasons—pushing the climb angle beyond the safe limit, and stretching the glide; more will be written in the last chapter on instruction.

This ship has proven to be non-stalling and non-spinning; the test pilot having flown the ship with the tail dragging at angles from 16 degrees to 25 degrees, with no tendency to stall, and in this position applied rudder both ways to aid the start of a spin but could produce none.

Control became sloppy, naturally. but, nevertheless, control remained, and stability also remained, the ship mushing forward and slowly downward.

This type wing has no sharp breaking point of lift, called burple point, but settles flat and under control at this dangerous condition.

In balance, a displacement of center of gravity five per cent either forward or aft of center pressure position in wing will result in no appreciable pressure on the stick in flight, providing correct tail length and tail areas have been attained.

A good stable tail length proven in practice is 2½ chord lengths from center of pressure point in wing to rudder post, the wing, of course, following the general practice of using an aspect ratio of six or very close to this figure.

An even better method is to draw a line from center span-center pressure position to wing tip; then swinging the tip end of line at right angles to wing will give the rudder-post position.

The percentages of areas in tail planes, et cetera, are too complicated to go into in detail in this article; but perhaps a later article on design practice and stress procedure will cover this field.

Another little tip in design: keep the tail planes approximately 30 per cent of wing chord, above or preferably below wing chord line to avoid their action taking place in the wash created by the wing in flight. The center of gravity in the complete airplane fully loaded—fuel, pilot in seat, etc., should be directly below the center of pressure point in the wing, which at 0 degree angle in normal flight (thick wings are usually mounted at 0 degree angle on light loaded jobs) which in this airfoil section ranges from 42 per cent of the chord from the leading edge at 0 degree angle, to 32 per cent at 14 degrees angle.

Theoretically, as the ship flies at 0 degree angle at top speed the 42 per cent figure should be chosen, but in practice the most forward C.P. point is usually used in balancing. In my experience with this wing. I have acquired best results by balancing ship on a point 38 per cent of chord from leading edge. This final balance is secured by mounting motor last and sliding same on bed forward or back till perfect balance is secured with full load (gas, oil, propeller, radiator, and pilot in seat). In blocking ship up for balance test, be sure loads are distributed so no undue strains are thrown on any one member of the structure.

Building

IN building a plane, it is best to start with the wing. I include drawing No. 4, which shows a rib in finished form.

They are to be made of 5/16" x 5/16" spruce preferably, and all ribs made in the same jig to secure a uniform wing job.

From figures on drawing 4, lay out in pencil a complete rib on a smooth wooden surface, full size. Then drive headless finishing nails of heavy gauge around this outline on both sides of all members, taking care to plan them so they will not interfere with gusset plates or hinder the removal of rib after assembly.

Rib should be lifted vertically off jig, leaving nails in wooden base for forming of the next rib.

Remove ribs carefully after gluing and gusset plating one side and immediately glue and plate the reverse side. All fits must be perfect for maximum strength.

Rib outline should conform exactly to figures given to secure an efficient wing.

The completed ribs thoroughly dried should be either sprayed or dipped in spar varnish, as should all wood work. All metal parts should be either varnished or lacquered.

In June RADIO NEWS

MAKING THE AIR SAFE FOR TRAFFIC—By Zeh Bouck.
WHAT FLYING HAS TO OFFER TRAINED RADIO EXPERTS—By E. R. Haas
THE "EXPLORER EIGHT"—By John B. Brennan, Jr.
THE "EVERYMAN A.C. SCREEN-GRID TUNER"—By Zeh Bouck
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THE "BEGINNER'S THREE"—By C. W. Palmer
SHORT-WAVE TROUBLE-SHOOTING—By H. M. Bayer
And Many Others

There will be 26 full-length ribs in the complete wing, but three or four extra should be made up to allow for breakage during assembly.

After the ribs and beams are made up, the wing may be assembled on saw-horses.

A more rigid job is obtained by building the wing in one single panel, therefore the saw-horse supports must be carefully leveled to eliminate any twist or wave the completed wing might have if this were neglected.

Five ribs on each wing end are cut for aileron as drawing shows.

Ailerons should be built with good clearance, eliminating chance of jamming in flight.

Rib spacing is clearly shown, ribs being nailed and glued to beams.

After ribs have been put in place, glued and nailed, the compression members may be installed, drag wire fittings attached to beams with ¼-inch steel bolts. Drag wires may be put in and tightened with turnbuckles. Care must be taken not to put enough tension in these wires to twist wing or place objectionable strains on compression members.

The five-gallon gas tank is held in a strap steel support made to fit the tank form and attached to compression members.

Aileron hinges are ordinary door hinges about one inch wide and cut and drilled to suit the purpose.

The center pin having been removed, surfaces are covered with hinge sections attached and mobile surfaces are later fastened by inserting cotter pin in place of the original pin, and spreading.

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MONOPLANE MATERIALS

SPECIFICATIONS

Span (total)	28 feet
Span (active)	26 feet
Chord	5 feet
Area (active)	130 square feet
Total weight	850 pounds
Horsepower	40-45 h.p. (rebuilt Chevrolet)
Load per square foot	6½ lbs. per square foot
Load per horsepower	20 pounds
Landing speed	30 miles per hour
Take-off speed	40 miles per hour
Cruising speed	70 miles per hour
Top speed	85-90 miles per hour
(Depends on propeller pitch to diameter)	
Cruising radius	2 hours

STEEL

Tubes	
Wing hold-down tubes	1¼" x .035"
Center section hold-downs	25/32 x 2 11/32 x .050" (57-180-2.)
Motor mount	¾" x .049"
Land gear spreaders	¾" x .065"
Axle	1" x .083"
Stabilizer brace	½" x .035"
Wing and tail plane outline	⅜" x .035"
Aileron horn brace	⅜" x .035"
Control stick	¾" x .049"

(All Tube Shelby—10-20 carbon but center hold-downs.)

FITTINGS

Hold-down fittings—at wing	3/32" x 3"
Hold-down fittings—at fuselage	3/32" x 1"

(All fittings cold rolled steel-mild carbon 57-136-3.)

MISCELLANEOUS

Land gear struts	1¼" x 2½" streamline ash
Wheels	18" x 3" (2 ply light 20" x 4" tire) 1" bore
Seat	Light sport, preferably reed
Aluminum for leading edge of wing	.010" half hard
Aluminum for cowling	.020" half hard
Control cables	Flexible ⅛"
Safety wire	(locking turnbuckles) .035" copper
Flightex	62 square yards

(To be concluded)

Air Brush For Decorating Small Objects

By Kenneth B. Murray

(Continued from page 127)

The bulb and short tube from an atomizer is next slipped over the central glass tube, forming the finished air brush, Fig. 5.

Fig. 6 shows the ease with which the air brush is used.

It must be borne in mind that the smaller the paint tube, the finer will the shading be. The tube is filled at the large end with an eye dropper. A little color goes a long way. Water color or thin paints may be used, although, of course, one should not attempt to use coarse house paint with such a fine spraying device.

With water color, the brush is cleaned by filling with water and spraying all of the remaining color and water out into the air. Turpentine can be used in the same manner with the oil colors.

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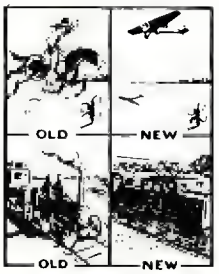

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Wood Turning

By H. L. Weatherby

(*Continued from page* 146)

The veneer used for the covering of this head should be thirty cut mahogany, or in other words, it should be one-thirtieth of an inch thick, and the dimensions should be about 8 inches by 25 inches. Any of the finer cabinet shops can provide this at a very slight cost.

Do not attempt to handle this thin veneer until it has been moistened, and then if time permits, wrap it around the turned head and let it dry in that position.

Next, make the cauls or forms as the illustrations indicate. These may be made of wood or sheet iron. If made of wood, a band saw will be needed to saw the forms to shape. When ready for glueing, the cauls and the head should be heated, the veneer moistened again to keep it from breaking and a light coating of hot glue spread over the head and the inside surface of the veneer. The cauls are placed as indicated with a piece of cardboard between caul and veneer, and the first clamp placed at the top, where the wood cauls are used. The veneer need not meet at the bottom, for an opening must be made here, in the head, to care for the swinging pendulum.

A caul may also be made of sheet iron or zinc and applied as the illustration shows. If cauls and head are heated, and the gluing is done in a warm room, there will be no need for haste. Trying to hurry through a job of this sort often results in poor work and blisters in the veneer. After the glue has been allowed to set, the head is ready for the face piece. For this job, saw a piece of mahogany to the approximate shape of the head and glue it in place to the front side. When this has set, chuck the head from the rear side to a block on the face plate, and turn the front of the clock, cutting out the hole for the dial. It would be well, however, before cutting this opening to purchase the works. These may be secured from your local jeweler, or ordered direct from companies advertising in this and other technical magazines, and of course the dial opening must be made to fit the movement to be used.

Turning Decorations

THE ornament at the top needs no explanation. It is fastened with a screw from the inside of the clock head after turning. The decoration at the bottom of the case calls for a glued-up piece, before turning, with paper in the joint, in order to split and give a half turning. This method was explained in an earlier issue of SCIENCE AND INVENTION.

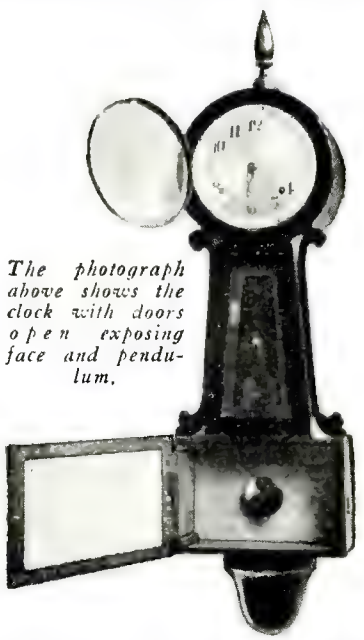
The Case

THE construction of the case from the head down is fully illustrated in the drawings and no difficulty should be experienced in constructing or assembling it. The different members are fastened together as indicated, the door is hung, the works are set, and tested, and the case is ready for finishing.

If mahogany, potassium di-chromate crystals dissolved in water used as a stain, followed by shellac and varnish rubbed to a dull finish, gives a very beautiful effect. If other wood is used, stain with a dark mahogany stain and follow with shellac and varnish.

Decorating the Glass Panels

IT seems to have been customary to use a marine view as the bottom decoration on banjo clocks. Occasionally, however, pastoral landscapes, colonial homes, or a hunting scene are used. The view decided upon, of course, may be hand-painted on the glass, but this would be a very difficult task to the average person, and it is suggested that a print be selected and cemented to the glass with varnish or paste. If varnish is used, apply a coat to the glass and to the front side of the print. Allow them to set until they become "tacky," then press the print to the glass and press out all air bubbles and allow to set.



The photograph above shows the clock with doors open exposing face and pendulum.

The panel above the door may be hand-decorated, either by the novice or by a sign painter at small cost. If the builder decides to decorate his own, after deciding on the design and colors, he may draw it out on paper and then by laying the glass over the design, he can duplicate the pattern on the glass in quick-drying enamels, oil colors or lacquers, after which the whole should be backed up with a smooth coat of gloss black.

If scrolls in gold are desired, it would be well to take the job to a sign painter for decorating.

If carefully made, the clock will make a beautiful heirloom for future generations, as well as a most satisfactory timepiece for now.

Next month we are going to give designs for two small tables with turned legs and stretchers.

Motor Hints

Conducted by George A. Luers

(*Continued from page* 134)

the strip as the drawing makes clear.

Regardless of the nature of the road, either uneven or soft, the jack by means of this attachment remains vertical. The long extension handle of the jack serves as the means to place the jack head on the fastener guide.

Parts are made up from strips of iron, the jack head being turned from bar iron stock. Almost any blacksmith can easily turn out the parts so that any owner desiring, can have these special features provided for his car.

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When Inventors Take Wings

By Joseph H. Kraus

(*Continued from page* 105)

speed. These planes might find it difficult to refuel in air because of the speed which they must maintain to float. Nevertheless, such a plane could easily fly from the top of a second mother plane, acquire speed as it flies down to earth and maintain this in establishing new records. Perhaps in the future such parent planes will also be used to bring the small craft back to the earth, after permitting their charge to nestle gracefully on top.

Most of the inventors look upon the practical side of aviation. There are a few who do not understand the principles of flight, and as a consequence, any patents which they might secure on ridiculous combinations would never meet with successful markets. An inventor who does not know a thing about aviation might find it difficult to interest any organization in the child of his brain, but an inventor who understands the difficulties with aircraft and who mixes this with the proper amount of intelligence, logic and common sense might produce the ultimate type of airplane.

A Stern Paddle-Wheel Houseboat

By Hi Sibley

(*Continued from page* 144)

we build our houseboat?" By all means at the waterside, if possible. It is true the twenty-foot side-wheeler preceding this new design was built twenty-five miles from its ultimate home and transported thither successively by dray, interurban flat-car and team of mules. A twenty-eight foot craft, as illustrated, is quite another problem. Better build it on the beach.

Painting

THE cotton caulking should be thoroughly soaked with white lead as soon as driven in and the surface of the completed scow given two coats of paint. It is not necessary to paint the inside of the scow, though such treatment might lengthen its life.

Everyone has his own ideas as to color schemes for a houseboat, but one cannot go wrong with a slate-grey scow, white cabin with green trimmings and canvas roof grey. Chinese red sets off the paddle-wheels.

Once your houseboat is launched in a stream or chain of lakes its possibilities for genuine recreation are unlimited; you can make a charming summer home in remote spots accessible only to a canoe or rowboat, and enjoy the seclusion possible only in such places.

A Radio Color Screen

(*Continued from page* 152)

mounted so that the lights are automatically turned off when the console doors are closed. The cylinders can be of glass suitably colored with lacquer, or of some lighter material such as colored gelatine. The simplest color arrangement would be to have three panels on each cylinder, one red, one green, and one blue. When the changing color curtain is used, all but the center portion of the grill is blocked off with black paper on the back. On the back of this center portion, a curtain of pleated white silk is fastened with the grill cloth left in place. When the lights are turned off, the appearance of the set is the same, but the changing colors become visible through the wide weave grill cloth when the lights are turned on. A curtain of thin black gauze is hung in back of the cylinders and extends all the way across the speaker compartment, preventing the loud speaker from becoming visible when the lights are turned on. The complete lighting arrangement need not take up more than four inches of space, as the cylinders can be about three inches in diameter.

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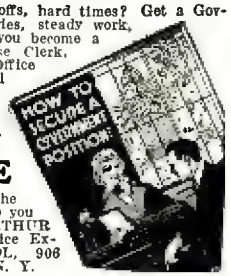

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How Much Power to Start a Train?

By Prof. Edward C. Schmidt

(*Continued from page* 109)

locomotive can exert a pull of 65,800 pounds; on a grade, however, this pull will be reduced by the force required to raise the locomotive itself up the grade. This force can be precisely calculated and it amounts on a half per cent grade to 10 pounds for each ton of engine weight. Since the locomotive and tender weigh 300 tons, the force required to raise them up the grade will be 300 x 10= 3,000 pounds. Subtracting this amount from the pull available on level track we get 65,800—3,000=62,800 pounds as the force available for hauling the train over this grade.

If we assume further that the train is to be composed of cars whose average weight is 20 tons, we find from curve A of Fig. 6 that for each ton of train weight it requires 7.3 pounds to haul the train on level track at ten miles per hour. As in the case of the locomotive, the resistance required to overcome the grade itself will amount to 10 additional pounds, so that on the assumed ruling grade we must provide for each ton of train weight 7.3+10.0=17.3 pounds of tractive force. If we now divide the total available tractive force, 62,800 pounds, by 17.3 pounds per ton, we obtain 3,630 tons as the gross weight of the train which this locomotive can haul over a half per cent grade at 10 miles per hour. Had we assumed that the train was to be composed of cars weighing on the average 45 tons per car, we should have found from curve B in Fig. 6 that the net resistance per ton would be 4.3 pounds instead of 7.3 pounds and that the train weight would be 4,390 instead of 3,630 tons. If, on the other hand, the train is to be composed of the heaviest loaded cars such as coal cars weighing 75 tons each, the net resistance on level track as shown by curve C would amount to only 3.2 pounds per ton, the gross resistance would be 3.2+10=13.2 pounds per ton, and the train weight would be 4,760 tons. We find, therefore, that the train weight to be allotted to the locomotive under the assumed conditions would be 3,630, 4,390, or 4,760 tons, depending upon whether the train be composed of cars of an average weight of 20, 45 or 75 tons respectively. This

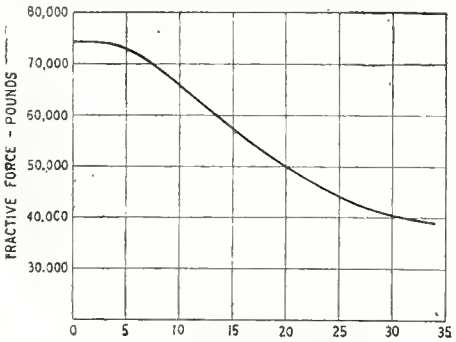

Fig. 7—Graph showing relation between tractive force of locomotive and speed in miles per hour.

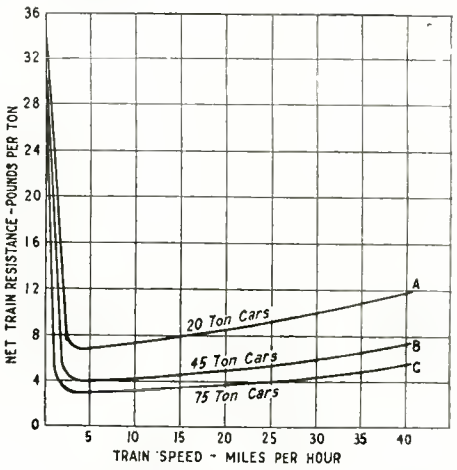

Fig. 6—Graph to show relation between train resistance and train speed in miles per hour.

variation in train load is due chiefly to the fact that in the heavier cars the coefficient of journal friction is less than in the lighter cars.

In this discussion of train resistance, no mention has been made of what is frequently the most important element of train resistance, namely, the *resistance due to acceleration*. It has been ignored because in freight train operation the rate of acceleration is generally very small and under the conditions which prevail on ruling grades it is quite negligible. In passenger service, on the other hand, and particularly in the operation of suburban trains or subway trains making frequent stops and starts, acceleration resistance is of the utmost importance. By acceleration is meant the increase of speed in a unit of time and it requires a great force to produce this speed increase. In subway trains, for example, the prevailing acceleration as the train gets under way is about 1.5 miles per hour per second. This means that one second after starting the train speed has increased 1.5 miles per hour; two seconds after starting its speed has increased another 1.5 miles per hour, so that at the end of two seconds the total speed attained is three miles per hour; and so on, up to the maximum speed of say 60 miles per hour, which will have been attained after the lapse of 40 seconds. To produce an acceleration of one mile per hour per second requires a force of about 100 pounds for each ton of train weight, and for the assumed acceleration of 1.5 miles per hour per second, which is frequently encountered in subway and suburban trains, it would require 150 pounds for each ton of train weight merely to produce this increase in speed; and this is in addition to the pull required to overcome the net resistance and the resistance due to grade. This force may be from ten to thirty times as much as is required for all other elements of resistance combined.

LORD KELVIN

THE expression, "Ad Infinitum," is frequently used in mathematics to express the idea that a line extends into space and never ends.

One of the greatest teachers of mathematics, physics, and chemistry was the renowned Lord Kelvin. His lectures at the University of Glasgow were always accompanied by mathematical demonstrations. His pupils seemed to fear the mathematical part of the work, for Lord Kelvin would frequently call upon them before his lecture started, to prove mathematically a point which he had illustrated in a previous lecture. This time he called upon a young man named Smith to recite.

Smith arose and in an uncertain tone said, "Professor, take a piece of chalk and draw a line."

Now Lord Kelvin was a very accurate teacher as is evident from his next question.

"How shall I draw the line?"

"Ad infinitum," was the astonishing reply.—*Contributed by J. Abrahams.*

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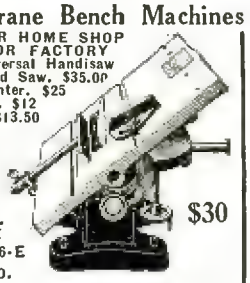

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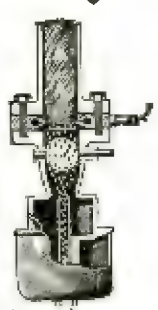

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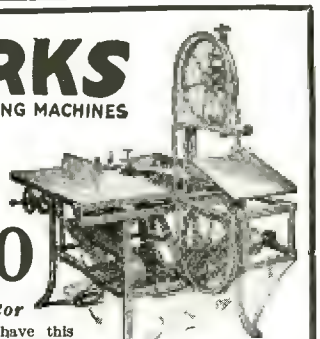

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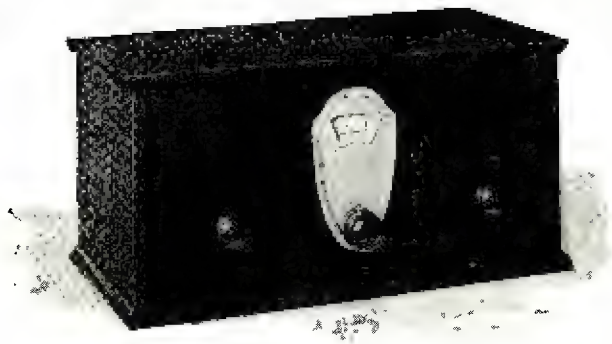

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Experiments With Powdered Metals

(*Continued from page* 135)

metal dust simply sheds the water or does not become wetted by the water, and the hand stays dry. This is an old experiment to many experimenters who have used lycopodium instead of powdered aluminum.

A very peculiar behavior of a metallic dust is observed when a little of the aluminum powder is sprinkled on the surface of water. It floats and soon comes to rest. If a very small drop of alcohol, or a liquid containing alcohol such as perfume or spirit of camphor, is poured on the water the metal scatters itself about in a most lively manner, soon coalescing in large areas so that metallic like plates or islands are formed. The effect is very curious to observe and is due to difference in surface tension between alcohol and water. If spirits of comphor are used, a white precipitate of finely divided camphor is produced which seems to make the action all the more lively.

A Ford spark coil usually gives a jump spark about a quarter of an inch long, often more. By the use of our metallic powder the jump of the spark can be increased to *six inches*. For this simple experiment a strip of wood should be taken and two binding posts mounted upon it and spaced about six inches apart from each other. Small metallic plates such as washers can be placed under the posts between them and the upper surface of the wood strip. Aluminum dust now should be sprinkled on the wooden strip between the two binding posts reaching from post to post. The dust should not be put on too thick for a metallic short circuit will be formed across the two binding posts. If the dust is applied sparingly a very high resistance will be formed by the dust, and here and there one will find open circuits in the trail of dust. It is these open spaces which allow the spark from the spark coil to pass. The discharge is not the straight jump spark discharge but seems to border on a brush effect. Nevertheless, the writer has obtained a sparking surface about six inches long using a Ford spark coil. Too much metallic dust must not be sprinkled between the posts but on the other hand a sufficient quantity is needed. The sparks cover an area under certain conditions of about five to six inches long and an inch wide.

Aluminum dust can be used to make hydrogen gas. When some of the metal is shaken with warm sodium hydroxide solution, hydrogen gas is given off freely, and can be used in many experiments such as that of reducing oxides, filling balloons, making detonating gas, etc. A solution of lye in water will take the place of sodium hydroxide.

A very curious experiment which the writer made when experimenting with some aluminum dust was that of charging each little speck or particle of metal with electricity and observing their behavior when given the chance to separate. The experiment is easily performed. A rubber comb, or better, a stick of sealing wax is charged by rubbing upon a piece of fur, with silk, or upon the trousers leg or other woolen cloth. It will become electrically charged. Now if some aluminum dust is dropped through the air and allowed to fall upon the charged wax, the little particles of metal will, upon striking the wax, become charged themselves, and all will be charged with the same kind of electricity—that of the charge upon the wax. Like charges of electricity repel each other, consequently each little charged metallic particle will try to get as far away from its neighbor as it can. How well the particles do this can only be told by performing the experiment. They seem to strike the charged sealing wax and then bounce off into the air like a golf ball thrown against a brick wall.—*Contributed by Raymond B. Wailes.*

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Is a College Education Worth While?

(*Continued from page* 107)

uplifting surroundings and learn the same important things outside which he might have opportunity to acquire at college. Yet it will be much harder. The set of the tide will be against such a course outside, while he can easily find a tide in college that will help him. Of course, there are other tides in college that tend toward demoralization, but everywhere in life there is always the choice to make between that which is positively good and that which is colorless or evil.

There are professions difficult to enter without college antecedents. Every year the colleges are called to recommend numerous young people to these professions. If one intends to be an engineer, a college teacher, a doctor, lawyer, or preacher, it is decidedly worth his while to attend and make a good record at the right kind of a college or technical institution of higher learning.

For those who do not propose to enter such professions, the bread and butter reason will not so plainly point to college. Yet the satisfactions of life depend largely on the contents of the mind. A well-stored memory, including not only book learning and the guides to right reading, but the recollection of inspiring contacts with real teachers, and the enthusiasms of young fellow-students, these are rich stores laid up against the drab or painful experiences of middle and later life. Such are the advantages that college may furnish to those whose professional duties do not actually demand its technical instruction.

Home Movies

By Don Bennett

(*Continued from page* 133)

motion analysis of sea gulls in flight. The amateur with a slow motion camera can expend some footage on this type of work to good advantage. I have also seen a four hundred foot reel of 10mm. film made by an amateur, a woman at that, of humming birds. She got them in range of her camera by fastening a test tube full of sugar water to a branch exactly in focus with the lens and only about two feet distant. Remote control of the camera-release by means of a string secured some excellent pictures for this amateur.

"At night fish can be attracted by lights on or under the water. If you want a good night's shooting, prepare by sinking a large piece of tin painted white or a white canvas weighted down with stones. This should be carefully lined up to be just in the right position when your camera is set. Be prepared to confine your shooting area and try to entice the fish into that area. Prepare the illumination by making bright reflectors for flares or by suspending incandescent lamps close to or in the water. If they are in the water, they must of course be waterproofed. The reflecting surface should be not more than four feet below the surface. Fig. 8.

"After dark, light one of your lights to attract the fish and when a sufficent number have assembled on your stage, light the rest of the lights and *shoot*. The light bottom will magnify the strength of your lighting equipment and also provide a light background for your fish. It should not be more than three or four feet under water." (Author's note: If you have no fish in your locality, we cannot help you to get fish pictures. Our only suggestion is to apply the above methods to your mermaid and mermen friends. See Fig. 9.)

"Thrilling films are those made of the tarpon and other game fish in our Florida waters. They are indisputable proof if that 'big one' gets away. A quick eye and a little experience are necessary to get pictures of these speedy creatures for they will twist and turn until you have a hard job keeping them on the screen. A two-inch lens should be used for such scenes in order to get the fish large enough in the picture to be recognized."

With these remarks Jones completed his talk and the lively discussion that followed showed that Rockland cinema circles were interested in capturing natural acting.

(Next month we will find Mr. Jones explaining some outdoor movie tricks. Don't miss it!)

Is Rocket Flying Possible

(*Continued from page* 113)

the pressure can be guided in any direction so as to steer the rocket. In ordinary fireworks the rocket-stick does this. The escaping gases do not depend upon the surrounding air for their action as a rocket would work with more power in a vacuum, but would be more quickly exhausted. Lt. Raimer, in a recent issue of the *Umschau*, say that the rocket of the Spandau fireworks laboratory, which with the weight of six pounds reached the height of 984 feet, is practically perfect. It must now be noted that the Sander rocket used by Opel in his experiments with a weight of 26 pounds obtained a height of about 4,920 feet. This rocket developed a thrust or push of about 529 pounds, which is 20 times its own weight. Eisfeld employed for his models a rocket of 1 1/3 pounds in weight, which with a properly proportioned gas nozzle gave a thrust of 66 pounds, which is fifty times its own weight. It is surprising that such a thrust can be given. To develop a slighter thrust so that a man in a rocket-driven car could stand the acceleration without being thrown from his seat, experiments have been made with solid filled rockets, namely, without any cavity. This reduced the combustion area and naturally the internal pressure.

All this gives the clue for the development of the rocket, without attempting to say that the limit of its efficiency has been reached. To prove the practicability of the improved rocket, Eisfeld, associated with Valier, built a model vehicle, which in a primitive way ran on wooden wheels without even having ball bearings. In the Opel experiments, the front of the wagon always lifted because the principal weight of the rocket was back of the rear axle, so a definite change was introduced by Eisfeld-Valier. They placed the rocket proper between the front and rear axles. The point of action of the power was therefore shifted from the rear axle to the front axle. Experiments showed that this change was correct. A model car weighing only 112 pounds attained in experimental tests the high velocity of 130 miles an hour, far more than was expected. As the railroad on which the car ran only gave a straight run of 3,936 feet, the car ran off the track when it met a curve and went to pieces. But this experiment showed what was to be desired; namely, a higher efficiency of the rocket with the expenditure of less material, and its proper location on the car.

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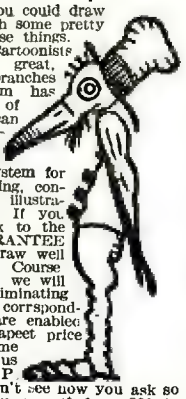

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It is going beyond our limits to explain why placing the entire body of the rockets back of the center of gravity of the car must always lead to failure. All that it is necessary to say is that such a car cannot be steered. The next element of the problem is to give the car the right form for the speed to be obtained. The speed of the escaping gases from the base of the rocket in the Eisfeld rocket is between 656 and 672 feet per second, that is to say, from 447 to 559 miles an hour. We may hope that this velocity by giving a proper shape to the car may yet be imparted to it. In the Eisfeld experiment there were six rockets, each giving 66 pounds of thrust, making a total of 396 pounds, which gave the 110-pound wagon a speed of 130 miles an hour. In later experiments on the tracks of the Halberstadt-Blankenburg Railroad, 25 rockets gave a speed of 62 miles an hour, and 36 rockets gave a speed of 149 miles. It will not be difficult to reach these higher speeds by increased thrust, combined with improved shape of the car. Rocket flying seems to be close at hand.

Light Sensitive Liquid Cell Has Many Applications

(*Continued from page* 122)

milliamperes of current and should have a resistance of 1,000 ohms. A 2,000 ohm potentiometer can be used.

Uses

A FEW applications of the light sensitive liquid cell have been illustrated on first page. Policemen or watchmen making their rounds can instantly turn on the lights in a store or building or any section thereof, by simply turning the beam from a flashlight upon the window in the photo-cell unit. The same device could be employed by railroads for automatically turning on the lights in the train as the cars travel through a tunnel, or, for turning on the lights when dusk approaches. In burglar alarm systems, a beam of infra-red or ultra-violet light which is invisible could be trained on the cell and so placed that the intruder would intercept the light beam when entering, thus, giving an alarm. Automobile headlights can also be switched on automatically when darkness approaches.

An exposure meter for the photographer could be made by noting the deflection of the galvanometer which would vary according to the amount of light. The scale could be marked off to coincide with the correct lens opening. For a novel window display, the cell unit could be placed at one end of an opaque cone, so that when the window shopper places his hand over or waves it in front of the cone, the light is momentarily shut off, operating the photo-cell unit which in turn could be used to open an electric circuit employed for running the display device. The garage doors could be opened by the light from the headlights by allowing the light control unit to throw a motor into the circuit, which in turn would open the doors. Buoys carrying warning lights could be equipped with this simple device and when night falls or during a particularly bad storm, the light is automatically turned on. As an economic saving, signboards could be illuminated only when a train passes, by either allowing the train to intercept a beam of light trained upon the cell, or by using the light from the train directly. The beam of light used could in this case, be either visible or invisible. It is obvious, however, that in the burglar alarm an invisible ray would have to be used. For further experiments with light sensitive cells, the reader is referred to the April 1929 issue of RADIO NEWS.

(*Name of manufacturer supplied on request*)

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Answers to Scientific Problems

(*Continued from page* 130)

Planetary Gears

LET point 1 on B (1B) be in contact with point 1 on the stationary gear C (1C) and point 9B be in contact with 1A. Now let B turn until all 16 of its cogs have meshed once with those on C. This will bring point 1B in contact with 17C. At the same time A will have turned so that sixteen of its cogs have meshed with B. This will bring 17A in contact with 9B. Thus while B is making ¼ of its circuit around A, the latter will have turned ¾ of a complete rotation. Therefore, while B is making a complete circuit, the central wheel A will rotate 4×¾ or exactly three times.

It may at first be thought that B will turn four times on its own axis while revolving once around A, but it should be noted that when B has made ¼ of a revolution around A, the point 1B will be in contact with 17C, and from the figure it can be seen that this means that B will have made only ¾ of a rotation on its own axis. During a complete revolution, therefore, B will turn 4×¾ or exactly three times.

Car Wheels

THE tread of each car wheel is turned so that the inner edge next to the flange has a larger diameter than the outer edge. Thus the surface of the wheel is conical instead of cylindrical. As a car swings around a curve, the wheel on the outside of the curve is thrown against its flange. The outer wheel, therefore, rides on its inner edge of large diameter. The wheel on the inner rail, on the other hand, rides on its outer edge of smaller diameter. Thus in effect it is a larger wheel that travels the longer outer arc of a curve, and a smaller wheel that travels the inner and shorter arc.

Heat and Weight

HEAT does not change the actual weight of a body appreciably. But unless a body is weighed under special conditions it will appear to weigh less on a chemical balance when the body is hot than when it is cold. This is because the body when hot will set up a convection current in the air upward past the body and downward past the pan with the counterbalancing weights. The expansion of the body may also make a slight change in its buoyancy, thereby tending to make it still lighter when hot. Then, too, a hot body will have less moisture sticking to its surface. For these reasons, chemists always cool and dry their samples under uniform conditions before weighing them, and the most accurate weighing has to be done in a vacuum.

Gold Foil

THE volume of a sphere one foot in radius would be 4/3 pi r^3=4.1888 cu. ft. Each cubic foot of gold would form 12×300,000 or 3,600.000 sq. ft. of foil. Hence the whole sphere would form 15,079,680 sq. ft. or enough to more than cover half a square mile of surface!

Motion of a Point on a Rim

THE only puzzling thing about this question is one that is due to a misconception of the true meaning of the word "stop." Ordinarily when a body stops we think of it ceasing to move forward for a definite interval of time. In this sense if any point on a rolling wheel should cease to move forward even for an infinitesimally small interval of time the whole wheel would cease to move forward for the same length of time. But obviously a point on the rim of a wheel cannot remain in contact with the ground, and at the same time be moving forward without slipping. The solution of this dilemma lies in the realization that in order for a body or a point to stop, it does not necessarily have to stop for any finite length of time.

Suppose we consider the motion of the point at any instant other than when it is in contact with the ground. It will have a certain speed with respect to the ground at each instant, and this speed will be different at each instant. At the top of the wheel the point will be moving parallel to the ground while at other times it will be moving upward or downward with a more or less diagonal motion. We cannot suppose any single speed to remain constant and unchanged even for an instant or the wheel would have to stop rolling. In other words, the speed of the point changes continuously, not discontinuously. Now when the point comes in contact with the ground it passes through zero velocity, just as continuously as it does through any other velocity. That is, the point actually stops but it does not stop for any length of time.

The Balloon

THE solution to this problem, like every other involving change of motion, must be sought in Newton's laws of motion. According to these laws we see that the balloon will remain at rest until some force is applied to make it move; and once it is in motion ,it will continue to move until some force stops it. From the second law of motion, we see that it is only while the man on the ladder is setting his body in motion with respect to the ladder that he exerts any extra force which could set the balloon in motion. That is, it is the jerk that he exerts on the rung of the ladder as he begins to climb that will set the balloon in motion downward. As long as he continues to climb uniformly, no further force will be exerted and the balloon will merely settle slowly, due to the first impulse that it received. When the man stops climbing the opposite effect is produced, for during the moment that he is stopping he will reduce, slightly, the force that he exerts on the ladder and the momentary buoyant force thus gained by the balloon will again bring it to rest.

Lightning Rods and Lightning

CONTRARY to common opinion a lightning rod does not ward off lightning. It actually encourages it. Lightning discharges to and from pointed objects much more readily than from rounded surfaces. In the absence of pointed objects, well connected to the ground, the electrical potential of a passing cloud will accumulate until the voltage is sufficient to cause a sudden and very disruptive discharge to take place. This discharge is characterized by its violence, light and noise. When a building is protected by properly installed lightning rods, these pointed objects draw off the charge from a passing cloud gradually and noiselessly and the potential may never get great enough to cause a bolt to pass. Even if a visible bolt does "fall," it is usually weaker and much less destructive than if no rod were present.

A Problem in Geography

IF a person travels north for a hundred miles, east a hundred miles and then south for a hundred miles he will usually, at least in the northern hemisphere, be more than a hundred miles from his starting point. This is because he is traveling on the surface of a great ball. His northward and southward journeys are not parallel but follow the meridians which converge at the north pole. If a person were near enough to the north pole, however, he might actually return to his starting point. In this case his eastward journey would be just long enough to enable him to make a complete circuit of the pole.

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"I GAMBLED 2¢ *and* WON $35,840 *in* 2 YEARS"

A Story for Men and Women who are dissatisfied with themselves

THIS is the story of a gamble—a 2c risk—which paid me a profit of $35,840 in two years. I am not, and never was, a gambler by nature; in all probability I never would have taken the chance if more money was involved. So even if you, too, are against gambling, you will feel like risking two cents after you've read my story.

Some people believe I was lucky. Others think I am brilliant. But this sort of luck I had everyone can have. My type of brilliance is that of any average man.

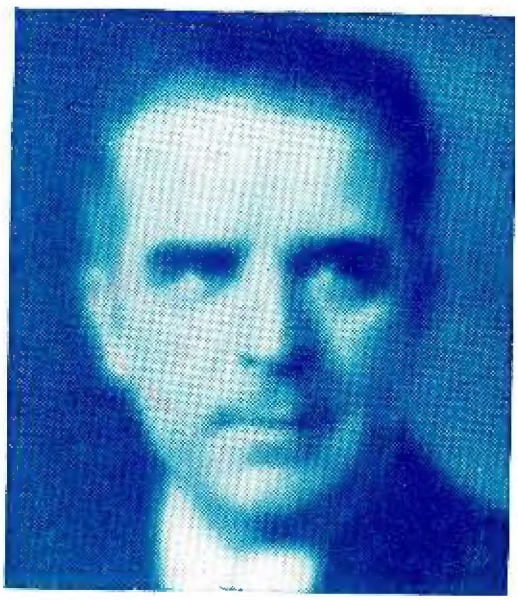
Almost any $40-a-week wage earner has as complete a mental equipment as I had two years ago. And he feels today just about the way I did then. For two years ago, I too, was in the $40-a-week rut. My earnings were $2,080 per year!

I was discontented, unhappy. I was not getting ahead. There didn't seem to be much hope in the future. I wanted to earn more money—a lot more money. I wanted to wear better clothes and have a car, and travel. I wanted to be on a par with people I then looked up to. I wanted to feel equal to them mentally and financially.

But it all seemed hopeless. I was beset with fears. I was afraid of losing my job. I was afraid of the future. I could see nothing ahead for myself and my wife and baby but a hard struggle. I would live and work and die—just one of the millions who slaved their lives away. I was irritable, easily annoyed, discouraged, "sore" at my fate and at the world. I could not think clearly. My mind was in a constant whirl. I was "scatterbrained." I had a thousand half-baked ideas to make more money, but acted on none of them.

The end of each year found me in about the same position as the beginning. The tiny increases in salary, grudgingly given to me, were just about enough to meet the rising costs of living. Rent was higher; clothes cost more; food was more expensive. It was necessary for me to earn more money. So once in a while I got a few dollars more. But it wasn't because of any great change in my ability.

Today I have an income of $20,000 a year. That's exactly $17,920 more than it was two years ago. A difference of $35,840 in two years. My family has everything it needs for its comfort and pleasure. My bank account is growing rapidly. I have my own home in the suburbs. I am respected by my neighbors, and I have won my wife and children's love as only the comforts and pleasures of life can do.



When I am old I will not be a millstone around anyone's neck. My children will not have to support me.

I look forward to the future with confidence and without fear. I know that only improvement can come with the years. Once I wandered through life aimlessly, cringing, afraid. Today I have a definite goal and the *will* to reach it. I know I cannot be beaten. Once my discontent resulted in wishes. Today my slightest discontent results in action. Once I looked forward hopefully to a $5 a week increase in salary. Today I look forward confidently to a $100 a week increase in my earnings.

What magic was it that caused the change in my circumstances? How did I, a $40-a-week clerk, change my whole life so remarkably? I can give you the answer in one word—Pelmanism. I gambled 2c on it. Yet without it, I might have continued in my old $40-a-week rut for the rest of my life.

Pelmanism taught me how to think straight and true. It crystallized my scattered ideas. It focused my aim on one thing. It gave me the will power to carry out my ideas. It dispelled my fears. It improved my memory. It taught me how to concentrate — how to observe keenly. Initiative, resourcefulness, organizing ability, forcefulness were a natural result. I stopped putting things off. Inertia disappeared. Mind-wandering and indecision were things of the past. With new allies on my side and old enemies beaten, there was nothing to hold me back.

I am writing this in appreciation of what Pelmanism did for me. I want other average men to gamble 2c as I did. For the cost of a postage stamp I sent for the booklet about Pelmanism, called "Scientific Mind Training." Reading that free book started me on my climb. I took no risk when I enrolled for the Course because of the Institute's guarantee. All I gambled was 2c and I am $36,000 better off now than I would have been had I not written for the book about Pelmanism.

* * * * *

The Pelman Institute will be glad to send a copy of "Scientific Mind Training" to any interested individual. This book is free. It explains Pelmanism. It tells what it does to the mind. It tells what Pelmanism has meant to others. For over 25 years Pelmanism has been helping people to happiness. Over 650,000 others have studied this remarkable science. Among those who have praised it are such great world figures as Judge Ben B. Lindsey, Jerome K. Jerome, Sir Harry Lauder, T. P. O'Connor, Major Gen. Sir Frederick Maurice, H. R. H. Prince Charles of Sweden, and many others. Your whole life may be altered as a result of reading "Scientific Mind Training." Send the coupon. You have nothing to lose. If Pelmanism does not help you it costs you nothing. There is no obligation in mailing the coupon. No salesman will call on you. Decide for yourself what to do after you read the free book about Pelmanism. Mail the coupon NOW.

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